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ABSTRACT

This two-volume set of papers was produced for the seventh International Gender and Science and Technology (GASTA) Conference. Abstracts of all papers and other presentations have been translated and are published in both English and French. Papers are published in the language in which they were submitted (English or French). GASAT provides a forum for individuals and organizations concerned about the inclusion of girls and women in the world of science and technology, from early childhood to work environments. Volume 1 includes the contributions which are concerned with schooling, including early childhood and those related to the workplace. It contains 53 papers, 6 symposia, 16 roundtables, and 14 workshops representing innovating intervention projects,.research findings, evaluative syntheses of interventions, and critical research reviews. Volume 2 contains 60 papers, 5 symposia, 3 roundtables, and 4 workshops representing innovating intervention projects, research findings, evaluative synthesis of interventions, and critical reviews for post-secondary education and living in a world community. (MKR)

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Sharon Haggerty, Ed.
Ann Holmes, Ed.

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Transformer les sciences et la technologie : notre avenir en dépend

Transforming Science And Technology: Our Future Depends On It

Volume 1

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Transforming Science And Technology: Our Future Depends On It

Volume 1
Contributions to the Seventh International Gender and Science and Technology Conference

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PREFACE

This book is Volume I of an edited two volume set of papers produced for the seventh International GASAT (Gender and Science and Technology) Conference, held July 31 to August 5, 1993 at the University of Waterloo in Waterloo, Ontario, Canada. The title of the contributions is taken from the conference theme, *Transforming Science & Technology: Our Future Depends On It*. Abstracts of all papers and other presentations have been translated and are published in both English and French. Papers are published in the language in which they were submitted (English or French).

GASAT provides a forum for individuals and organizations concerned about the inclusion of girls and women in the world of science and technology, from early childhood to work environments. Previous conferences have been a contributing force in the advancement of knowledge, understanding and program development on the issue of gender and science and technology. Past international conferences have been held in Eindhoven, The Netherlands (1981); Oslo, Norway (1983); London, U.K. (1985); Ann Arbor, U.S.A. (1987); Haifa, Israel (1989) and Melbourne, Australia (1991).

The GASAT Association is concerned with issues arising from interactions between gender and science and technology. Its objectives are:

- to encourage research into all aspects of gender differentiation in science and technology education and employment;
- to foster gender equity in science and technology, in education and in the workplace;
- to facilitate the entry of women into employment in the fields of science and technology, and their progress within such employment;
- to foster socially responsible and gender-inclusive science and technology;
- to provide a forum for dissemination and discussion of research findings and experiences of those working in the field;
- to provide a support network for those working towards the objectives outlined above.

Over 150 contributions from some 20 different countries spanning six continents are represented in these two volumes, with papers, symposia, workshops and round tables addressing the four aspects of activity in the field of gender and science and technology:

- Current Innovative Intervention Projects
- Research Findings
- Evaluative Syntheses of Interventions
- Critical Research Reviews

Additional sessions may be added to the agenda of GASAT 7. For further descriptions see *Volume III, Proceedings* October 1993. These contributions bring together perspectives, initiatives and ideas which are at the forefront of world-wide activity in the area of gender and science and technology. We anticipate that the research and experiences presented in these volumes will expand horizons and stimulate further thinking in the area.

Sharon Haggerty **Ann Holmes** **Mary Beam**

INTRODUCTION

Ce livre est le volume I d'une série de deux volumes de documents de recherche créés pour la septième conférence biennale sur l'équité des sexes en sciences et en technologie (GASAT -- Gender and Science and Technology), qui se tiendra du 31 juillet au 5 août 1993 à l'Université de Waterloo, Waterloo, Ontario (Canada). Le titre des soumissions est repris du thème de la conférence, *Transformer les sciences et la technologie : notre avenir en dépend*. Les sommaires de tous ces documents et des autres présentations ont été traduits et sont publiés en français et en anglais. Les documents de recherche sont publiés dans la langue choisie par l'auteure ou auteur (français ou anglais).

La GASAT sert de tribune aux personnes et organismes qui oeuvrent pour que les jeunes filles et les femmes participent activement aux sciences et à la technologie, de la petite enfance au milieu de travail. Les six conférences précédentes ont joué un rôle important en favorisant le développement des connaissances et l'élaboration de programmes dans le domaine de l'équité des sexes en sciences et en technologie. Les conférences internationales précédentes ont eu lieu à Eindhoven, Pays-Bas (1981); à Oslo, Norvège (1983); à Londres, Grande-Bretagne (1985); à Ann Arbor, États-Unis (1987); à Haïfa, Israël (1989); et à Melbourne, Australie (1991).

L'Association GASAT s'intéresse vivement aux questions que soulève l'interaction des sexes, des sciences et de la technologie. Ses objectifs sont les suivants :

- favoriser la recherche portant sur toutes les questions relatives à l'inégalité des sexes dans les domaines des sciences et de la technologie, à l'école comme au travail;
- promouvoir l'équité des sexes en sciences et en technologie, à l'école et en milieu de travail;
- encourager les femmes à faire carrière en sciences et en technologie et les aider à progresser dans ces domaines;
- préconiser la responsabilité collective et individuelle ainsi que l'équité des sexes en sciences et en technologie;
- servir de tribune de diffusion et de discussion des travaux de recherches et des expériences des personnes qui oeuvrent dans ces domaines;
- fournir un réseau de soutien aux personnes et organismes qui cherchent à réaliser les objectifs indiqués ci-dessus.

Plus de 150 soumissions de 20 pays des six continents sont présentées dans ces deux volumes. Elles représentent des rapports de recherche, des symposiums, des ateliers et des tables rondes adressant les quatre sous-thèmes du programme sur les sexes et les sciences et la technologie :

- Projets d'intervention novateurs courants
- Recherches
- Synthèses d'intervention
- Analyses critiques de la recherche

D'autres séances peuvent être ajoutées à l'ordre du jour de la conférence GASAT. Pour d'autres descriptions, voir *Volume III, Les Actes de la conférence*, October 1993.

Ces soumissions réunissent les points de vue, les initiatives et les idées à l'avant-garde des efforts mondiaux dans le domaine des sexes et des sciences et de la technologie. Nous espérons que la recherche et les expériences présentées dans ces volumes élargiront les horizons et stimuleront la réflexion dans ce domaine.

Sharon Haggerty **Ann Holmes** **Mary Beam**

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The GASAT 7 conference is co-sponsored by the Ontario Women's Directorate and the University of Waterloo. La conférence GASAT 7 est marainée par la Direction générale de la condition féminine de l'Ontario et l'Université de Waterloo.

Much appreciation is expressed for the patronage of the Ontario Ministry of Education and Training and the Social Sciences and Humanities Research Council of Canada. Nous tenons à remercier le ministère de l'Éducation et de la Formation de l'Ontario, ainsi que le Conseil de recherches en sciences humaines du Canada pour leur soutien financier.

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We warmly thank the staff of the Ontario Women's Directorate for their support and cooperation in the achievement of the conference. Nous remercions chaleureusement les employées de la Direction générale de la condition féminine de l'Ontario pour leur soutien et collaboration au succès de la conférence.

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ORGANIZATION OF THE CONTRIBUTIONS

Contributions are organized by format, level of focus, and finally by activity theme. *Volume I* includes the contributions which are concerned with schooling, including early childhood and those related to the workplace. *Volume II* includes all other contributions. Each volume is organized into four major categories, based on the format of the presentations: papers, symposia, workshops and round table.

Papers are published first, followed by abstracts of the symposia, round tables and workshops, in that order. In *Volume I*, Education and the Workplace are each placed in separate sections; in *Volume II*, Post-Secondary Education and Living in a World Community are also separated. These sections are further divided into sub-sections which reflect the four sub-themes of activities in the field of gender and science and technology: intervention projects, research reports, syntheses of interventions and critical research reviews.

Within each of these sections, papers and abstracts are organized alphabetically by the first author's name. For ease of identification and cross-referencing, a separate alphabetical index of all authors is also provided.

L'ORGANISATION DES SOUMISSIONS

Les soumissions sont divisées selon le thème, l'optique choisi et la forme. Le *volume I* comprend les soumissions qui sont reliées à l'éducation, de la petite enfance jusqu'au milieu de travail, et le *volume II* comprend tous les autres soumissions. Chaque volume est divisé en quatre catégories principales, selon la forme des présentations : rapports de recherche, symposiums, tables rondes et ateliers.

Les rapports de recherche apparaissent en premier, suivis des résumés des symposiums, des tables rondes et enfin des ateliers. Le *volume I* est divisé en deux sections: éducation et milieu de travail et dans le *volume II*, on retrouve enseignement postsecondaire et la vie dans une collectivité mondiale. Chacune de ces sections sont divisées en sous-sections, qui reflètent les quatre sous-thèmes du programme sur les sexes et les sciences et la technologie : projets d'intervention, recherches, synthèses d'interventions et analyses critiques de la recherche.

Dans ces sous-sections, les documents de recherche sont classés par ordre alphabétique (nom de la première auteure ou du premier auteur). Pour faciliter l'identification et la concordance, un index alphabétique séparé de toutes les auteures et tous les auteurs est également fourni.

TABLE OF CONTENTS/TABLE DES MATIERES

VOLUME I

PAPERS/RAPPORTS DE RECHERCHES

Page

ELEMENTARY AND SECONDARY EDUCATION/ÉDUCATION PRIMAIRE ET SECONDAIRE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Rosy Agholor. Australia
Factors Associated with the Under-Representation of Women in Science and Technology in Africa 1

Judith A. Bazler. USA.
A Bilingual Science Intervention Model 10

Judith A. Bazler, Arnold R. Spokane and Charlotte Collier. USA.
The Jason Project Experience and Attitudes Toward Science as an Enterprise and Career: Phase II 20

Erica Belling, Julia Biedermann and Debra Fletcher. Canada.
APEO Initiative Encouraging Girls to Keep Maths and Sciences through High School 29

Kamala Chandrasekhar. India.
A Female Relevant Science and Technology 39

Val Clarke and Joy Teague. Australia.
The Rationale, Development and Evaluation of a Video to Encourage Girls to Study Computing 46

Peter D. Hiscocks. Canada
Implementing an Engineering Summer Camp 56

Lore Hoffman. Germany.
An Intervention Project Aimed at Giving Girls a Better Chance in Science 66

Gillian Lovegrove, Wendy Hall and Mari Booker. UK.
The IT EQUATE Action Research Project in the UK 68

Jeffry V. Mallow. USA.
The Science Learning Climate: Danish Female and Male Students' Descriptions 78

Robina Otrupcek. Australia.
Preparing Boys to Share the Load 88

Carla Pieterson and Arthur N. Geddis. Canada.
Elementary School Girls Confront an Androcentric Science 97

Chandralekha Raghuwanshi. India.
Girls and Science and Technology in Indian Schools 107

Jo Sanders. USA.
A Large American Project that Got Thousands of Girls into Mathematics, Science and Technology 109

Eileen Scanlon, Tim O'Shea, Sara Hennessy, Josie Taylor and Denise Whitelock. UK.
Gender, Computers and Group Work in Science 118

Barbara L. Sherriff. Canada.
The University of Manitoba Access Program for Women in Science and Engineering 128

Jean Surry, Marjorie Sheasby, Janet V. Collins and Tracy Baker. Canada.
Open Doors: The History, Implementation and Evaluation of a Role Modelling Program 138

Karen E. Tarr. Canada.
Making Women's Voices Heard in the Classroom: An Issues Approach to Science 148

G. Joy Teague, Valerie A. Clarke and Marion L. Lyne. Australia.
A Computer Holiday Program for Year 10 Girls 158

Shadia A. Tel. Jordan.
The Effect of Having Women Instructors as Role Models on Perceptions of Performance in Chemistry 168

2. Research Findings/Recherches

Joan O. Amarteifio. Botswana.
Girls and Science Education in Sierra Leone 177

Tortiv Ato. Nigeria.
Factors Related to Girls' Attitudes Towards Career Interest in Science in Benue State of Nigeria 187

Dinesh Chandra and Archana Sharma. India.
Sex Gradients and Success of School Girls in Science and Technology in the Third World 197

Deborah A. Chetcuti. Malta.
Adolescent Girls' Views on Science: A Maltese Study 207

Joseph M. Cumo and Doris G. Simonis. USA.
Gender Effects of Learning Cycle Method on Student Learning in Seventh Grade Life Science Classes 217

Linda Eyre. Canada.
Course Choice and Girls' Visions of Their Futures 225

Sharon Frantz and Catharine Warren. Canada.
A Kid's Computer Camp as a Social Microcosm for the Study of Female Avoidance of Technological Training 235

Jim Gaskell. Canada.
Participation in Senior Level Mathematics and Science Courses and the Issue of Gender 244

Gaell Hildebrand and Andrea Allard. Australia.
Transforming the Curriculum Through Changing Assessment Practices 254

Trish Yourst Koontz. USA.
Longitudinal Study of a Middle School Physical Science Intervention Program 264

Magda Man in't Veld and Theo Wubbels. The Netherlands.
Using Teaching Strategies for a Better Physics Education for Female Students Aged 14-15 in General Secondary Education 274

Patricia Murphy. UK.
Equity and Assessment 276

Sharon Parsons, Catherine DeLauter and Blanca De La Torre. USA.
In a Different Voice: Empowering Female Elementary Teachers in Science 288

Heather Ryan. Canada.
Talking Girls Out of Science 298

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Sandra Acker and Keith Oatley. Canada.
Gender Equity and Computers in Context 308

Judy Emms and Gill Kirkup. UK.
Establishing Mentoring Schemes 318

Joyce Nyhof-Young and Judith K. Bernhard. Canada.
Toward Girl-Friendly Science: A Survey of Interventions for Elementary Teachers in Ontario 328

Laura J. Selleck. Canada
The COU Committee on the Status of Women: A Model for Change in Postsecondary Systems 338

Helene Sørensen. Denmark.
You Have to do More than Just Tell Them! 348

4. Critical Research Review/Analyse critique de la recherche

Jane Gilbert, Elizabeth McKinley and Beverley Bell. New Zealand.
Collaborative Research and Teacher Development: Issues for Feminists Working in Science Education 358

Heather-Jane Robertson. Canada.
"A Capella" - Situating Science in the Reality of Girls' Lives 368

WORKPLACE/MILIEU DE TRAVAIL

1. Innovative Intervention Projects/Projets d'intervention novateurs

C.A. Afolami. Nigeria.
Women-in-Agriculture Programme in Nigeria 378

Norma Dogger and Marilyn Dickson. Canada.
Developing a Women's Computer Network 387

Yael Rom. Israel.
The Recruiting and Training of Female Veteran Soldiers Towards Careers in Technology 397

2. Research Findings/Recherches

Nessy Allen. Australia.
A Woman of the Skies: An Australian's Contribution to Atmospheric Physics 407

Mary R. Anderson. USA.
Career Change Women Engineers: How are They Doing? 417

Clara H. Greed. UK.
Women Town Planners: Staying the Course 419

Ahbor Dolly A. Ighoroje. Nigeria.
The Brain Drain Phenomenon: A Case Study of the Trend in the College of Health Sciences, University of Benin, Benin City, Nigeria--How Involved are the Female Scientists? 429

Hilary M. Lips, Jerri L. Frantzve, Christina Wynings, Richard Castor, Brian Pack and Karen Wilson. USA.
Gender, Position and Computers in the Workplace 439

Gillian Smith and Anne Walton. UK.
The Fledgling Project: Mutual Support Strategies for Women in Employment 449

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Cecile K.M. Crutzen. The Netherlands.
A Female View on the Design of Information Systems 459

4. Critical Research Review/Analyse critique de la recherche

Janice Ahola-Sidaway and Margaret McKinnon. Canada.
A Critical-Feminist Perspective on Secondary School Work Education Curriculum 469

Isabelle Deschamps. Canada.
La Gestion de la Technologie au Féminin 479

SYMPOSIA/COLLOQUES

ELEMENTARY AND SECONDARY EDUCATION/ÉDUCATION PRIMAIRE ET SECONDAIRE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Nancy Cook, Cinda-Sue Davis, Mary Ann Evans, Ellen Mappen, Elizabeth O'Connell-Ganges and Kathleen Sullivan. USA.
Summer Science and Technology Programs for Young Women 489

Kerrie Mullins Gunst and Walter S. Smith. Australia and USA.
International Networking Springing from GASAT to Encourage Early Adolescent Girls in Science 491

Elizabeth Smyth and Ron Champion. Canada.
Encouraging Bright and Gifted Female Adolescents in Technology and Entrepreneurship: The Shad Valley Experience 493

2. Research Findings/Recherches

Andrea Allard, Gaell Hildebrand and others. Australia.
Gender Construction and Science Teacher Education: Models for Change 495

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Council of Ontario Universities Committee on the Status of Women. Canada
Advancing Women in University Science and Technology: The Role of Postsecondary Stakeholders 497

4. Critical Research Review/Analyse critique de la recherche

Debra Hayes (Australia); Else-Marie Staberg (Sweden); Monique Volman. (The Netherlands) and Vicky Webber (USA)
Researching, Representing and Reforming Girls' School Experiences: An International Comparison of the Discourse on Girls in Science and Technology Education 499

ROUND TABLES/TABLES RONDES

ELEMENTARY AND SECONDARY EDUCATION/ÉDUCATION PRIMAIRE ET SECONDAIRE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Susan M. Brown. Australia.
The Use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science 501

Cecile K.M. Crutzen. The Netherlands
The Olympiades in Mathematics, Physiks, Chemistry, Informatics 503

Barb Leek, Jane Dalton and Jan Clarke. Canada.
Expanding Options to Kindle Girls' Interests and Aspirations in Science and Technology 505

Lois McLean and Richard Tessman. USA.
Women in Science: A Multimedia Database 507

Elinor Nicoll and Nan Armour. Canada
Do Intervention Strategies Make a Difference? 509

Annette Sharp. Australia.
Girls, Science, Information Technology and Creativity 511

2. Research Findings/Recherches

Jane N. Mulemwa. Uganda.
Research in the Area of Girls' Participation in the Sciences 513

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Shirley Avril Canada
The Role of Government in Promoting Educational Equity for Girls in Science 515

Stella Williams Nigeria
Women in Science in Africa: the Twenty-First Century 517

4. Critical Research Review/Analyse critique de la recherche

Ron Lancaster and Shelly Beauchamp Canada
Math Competitions: Are They Unfair to Women? 519

WORKPLACE/MILIEU DE TRAVAIL

1. Innovative Intervention Projects/Projets d'intervention novateurs

Josée Morin Canada
Promoting Scientific Careers for Women in a Defense Research Establishment 521

Lillebit Nordhus and Benthe Stig Norway and Denmark
"Job-Profile": New Ways of Upgrading Women Workers and Servicing Companies 523

2. Research Findings/Recherches

Mona Dahms Denmark
Gender Studies in Third World Countries - Who Benefits? 525

Tami Wall and Debra Anderson Canada
Saskatchewan Women in Engineering - Growing Strong 527

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Fran Abramowitz Canada
Women in Railroading: A Non-Traditional Industry for Women 529

Peggy Tripp-Knowles Canada
The Glass Ceiling in Science Academia for Women 531

WORKSHOPS/ATELIERS

ELEMENTARY AND SECONDARY EDUCATION/ÉDUCATION PRIMAIRE ET SECONDAIRE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Sandra Bruzga. Australia
Family Science 532

Bev Dick and Jacqui Ryan. Australia.
Gender and Technology Studies at Primary School Level: A Book and an Inservice Course for Teachers 533

Karen Hansen. Canada.
Linking Elementary School Teachers and Students to the Faculties of Science and Engineering 535

Christine Hill. Canada.
Igniting the Spark: Classroom Practices for Encouraging Transition Years--Female Students in Science and Technology Studies 537

Valerie C. Johnston. Canada.
Empowerment Through Technology 539

Lynne Joslyn. Australia.
Xerox Poster Art: Defining a Feminist School/Workplace 541

Cheryl Kristjanson. Canada.
Making Connections: A Feminist Perspective 543

Barb Leek, Jane Dalton and Jan Clarke. Canada.
Becoming Adept and Comfortable with Science and Technology Curricula 545

Rebecca L. Lubetkin and Marylin A. Hulme. USA.
Science Teams 547

Janet Mays and Rosemarie Volpe. Canada
WAMMO, The Career Game 549

McClintock Collective. Australia.
An Introduction to the McClintock Teaching Strategies 551

McClintock Collective. Australia.
A Gender and Science Course for Teachers: The McClintock Collective Structured Course 553

Walter S Smith USA
COMETS, an Intervention Strategy to Encourage Early Adolescent Girls in Science 555

WORKPLACE/MILIEU DE TRAVAIL

1. Innovative Intervention Projects/Projets d'intervention novateurs

Mable Jones USA
Training Program on Operation Find 557

INDEX

Abramowitz, Fran 529
Acker, Sandra 308
Afolami, C A 378
Agholor, Rosy 1, 1076
Ahola-Sidaway, Janice 469
Allard, Andrea 254, 495
Allen, Nessy 407
Amarteifio, Joan O 177
Anderson, Debra 527
Anderson, Mary R 417
Armour, Nan 509
Ato, Tortiv 187
Attiyat, Abdulrahman S 683
Avril, Shirley 515
Baignée, Alison 691
Baker, Tracy 138
Banks, Kathy 1050
Bazler, Judith A 10, 20
Bearlin, Margaret 559
Beauchamp, Shelly 519
Bell, Beverley 358
Belling, Erica 29
Benckert, Sylvia 874
Bernhard, Judith K 328
Beyer, Karin 883
Biedermann, Julia 29
Bonde, Kis 903
Booker, Mari 68
Brainard, Suzanne G 569
Braundy, Marcia 579, 1072
Brown, Susan M 501
Browning, Kathy 1084
Bruzga, Sandra 532
Cairncross, Rosalind 1078
Carter, Ruth 864
Castor, Richard 439
Chacko, Indira 701
Champion, Ron 493
Chandra, Dinesh 197
Chandrasekhar, Kamala 39
Chapman, Olive 711
Chavarria, Silvia 1060
Chetcuti, Deborah A 207
Ching, Hilda 589
Clarke, Jan 505, 545
Clarke, Valerie A 46, 158
Collier, Charlotte 20
Collins, Janet V 138
Conwell, Esther M 1074
Cook, Nancy 489
Cosgrove, Mark 832
Côté, Manon 952
Crutzen, Cecile K 459, 503
Cukier, Wendy 591
Cumming, Sally M 601
Cumo, Joseph M 217
Dagg, Anne Innis 611
Dahms, Mona 525
Dalton, Jane 505, 545
Davis, Fran 730
Davis, Cinda-Sue 489, 721, 782
De La Torre, Blanca 288
DeLauter, Catherine 288
Dench, Sarah J 613
Deschamps, Isabelle 479
Desrochers, Debra A 621
Dick, Bev 533
Dickson, Marilyn 387
Dogger, Norma 387
Doron, Rina 740
Downey, Katherine H 750
Dresselhaus, Mildred S 1074
Dufresne, Marielle 910
Durndell, Alan 760
Dyck, Lillian E 1080
Emms, Judy 318
Evans, Mary Anne 489
Eyre, Linda 225
Farmer, Bev 1076
Fletcher, Debra 29
Fowler, Ruth A 1074
Foy, Louis 893
Frantz, Sharon 235
Frantzve, Jerri L 439
Frize, Monique 920
Gallagher, Patricia 772
Galopin, Michel 952
Gaskell, Jim 244

Geddis, Arthur N. 97
Giese, Patsy Ann 631
Gilbert, Jane 358
Gillbert, Catherine 641
Godin, Caroline 1086
Gonbaeu Hansen, Kirsten 770
Greed, Clara H. 419
Green, K. 1080
Haggerty, Sharon 1076
Hall, Wendy 68
Hansen, Karen 535
Harding, Jan 1088
Hayes, Debra 499
Hegarty-Hazel, Elizabeth 772
Henderson, Jerald M. 621
Hendriks, Martha L. 601
Hennessy, Sara 118
Hildebrand, Gaell 254, 495
Hill, Christine 537
Hiscocks, Peter D. 56
Hocking, Colin 930, 1090
Hodgson, Barbara 901
Hoffman, Lore 66
Hollenshead, Carol 721, 782
Holmes, Ann 1076
Hulme, Marylin A. 547
Ighoroje, Ahbor Dolly A. 429
Inch, Jeanne 990
Israelsson, AnnMarie 940
Johnston, Valerie C. 539
Jones, Mabel 557
Joslyn, Lynne 541
Kazinja, Victoria A. 950
Kirkup, Gill 318
Kolmos, Anette 792
Koontz, Trish Yourst 264
Kristjanson, Cheryl 543
Lafrenière, Josée 1086
Lancaster, Ron 519
Leclerc, Lyne 990
Learmont, Jeanette 651
Leek, Barb 505, 545
Levine, Karen B. 613
Lewis, Sue V. 661
Lightbody, Pauline 760
Lindley, Jennifer 651
Lips, Hilary M. 439
Logan, Peter 772
Lovegrove, Gillian 68
Lubetkin, Rebecca L. 547
Lyne, Marion L. 158
MacNeill, T. 1080
Madill, Helen M. 1040
Mallow, Jeffry V. 78
Man in't Veld, Magda 274
Manis, Jean Denby 802
Mappen, Ellen 489
Marchand, Francoise 952
Matyas, Marsh Lakes 1074
Mays, Janet 549
McClintock Collective 551, 553
McDonald, Karen A. 621
McKinley, Elizabeth 358
McKinnon, Margaret 469
McLean, Lois 507
Mitchell, Georgette 980
Moffatt, Ken 1000
Moore, Nancy 1092
Morin, Josée 521
Mulemwa, Jane N. 513, 962
Mullins Gunst, Kerrie 491
Murphy, Patricia 276
Naugah, Jayantee 971
Nicoll, Elinor 509
Nordhus, Lillebit 523
Norlen, Valerie 1070
Nyambala, Paul M. 671
Nyhof-Young, Joyce 328
Oatley, Keith 308
O'Connell-Ganges, Elizabeth 489
Okeke, Eunice 978
O'Shea, Tim 118
Otrupcek, Robina 88
Pack, Brian 439
Papa, B. Regina 812
Parker, Lesley H. 1010, 1030, 1076
Parsons, Sharon 288, 1020
Paschal, Carol 990
Pieterson, Carla 97
Raghuwanshi, Chandralekha 107
Rennie, Léonie J. 1010, 1030
Robertson, Heather-jane 368
Rom, Yael 397
Rudd, Lionel W. F. 980
Ryan, Heather 298
Ryan, Jacqui 533

Sanders, Jo	109
Scanlon, Eileen	118
Schmitz, Jan	1080
Scholer, Anne-Marie	822
Scott, Joan	681
Segal, Gilda	832
Selleck, Laura J.	338, 497
Sharma, Archana	197
Sharp, Annette	511
Sheasby, Marjorie	138
Sherriff, Barbara L.	128
Simonis, Doris G.	217
Simpson, Barbara E.	842
Skidmore, Linda	1074
Smith, Walter S.	491, 555
Smith, Gillian	449
Smyth, Elizabeth	493
Sørensen, Helene	348
Spink, Jillian	852
Spokane, Arnold R.	20
Staberg, Else-Marie	499, 874
Steiger, Arlene	730
Stig, Benthe	523
Sturgeon, Karen	1094
Sullivan, Kathleen	489
Surry, Jean	138
Tarr, Karen E.	148
Taylor, Josie	118
Teague, G. Joy	46, 158
Tel, Shadia A.	168
Tessman, Richard	507
Tobias, Sheila	1082
Tovell, Dorothy R.	1040
Tripp-Knowles, Peggy	531, 1094
Volman, Monique	499
Volpe, Rosemarie	549
Wall, Tami	527
Walton, Anne	449
Warren, Catharine	235
Watt, Helen	760
Webber, Vicky	499
Whitelock, Denise	118
Williams, Stella	517
Willoughby, Lynette	864
Wilkinson, Suzanne	862
Wilson, Karen	439
Wubbels, Theo	274
Wynings, Christina	439

FACTORS ASSOCIATED WITH THE UNDERREPRESENTATION OF WOMEN IN SCIENCE AND TECHNOLOGY IN AFRICA

Rosy Nkechi Agholor

L'écart entre l'accès et la participation des femmes et des hommes dans le domaine des sciences et de la technologie en Afrique est évident. Bien qu'il se resserre lentement, cet écart est encore relativement important et demeure un objet de préoccupation constant. Ce document a pour principal but d'examiner les facteurs qui contribuent à cet écart. Ces facteurs sont divisés en cinq catégories : communautaires, familiaux, scolaires, influence gouvernementale et perceptions et préférences des étudiantes et étudiants. Les stratégies visant à promouvoir la représentation des filles et des femmes dans le domaine des sciences et de la technologie en Afrique sont abordées à la fin de ce document.

FACTORS ASSOCIATED WITH THE UNDERREPRESENTATION OF WOMEN IN SCIENCE AND TECHNOLOGY IN AFRICA

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ABSTRACT

Emerging evidence has revealed a gap in the access and participation of females in science and technology in Africa. Although narrowing, this gap is still significantly wide and a matter for concern. The prime intention in this paper is to examine the factors that are associated with this gap. Factors falling under five clusters were identified. These are community-related, home-related, school-related, government influence and students' perceptions and preferences. Strategies for promoting the representation of girls and women in science and technology in Africa are discussed in the concluding part of the paper.

INTRODUCTION

In a world that is becoming increasingly dominated by science and technology, it is expedient for all, men and women alike, to be science and technology literate. In Africa, this expediency has been underscored by UNESCO (1992) with an enunciation of benefits at the individual and national levels. At the individual level, science and technology are seen as tools for a better understanding of the environment, and an antidote to superstitions, taboos and ignorance. At the national level, science and technology are identified as factors in industrialization and economic and social development. The Declaration of the World Conference on Education for All held in Jomtien, Thailand in 1990 and the ICASE/UNESCO follow-up mechanism of the conference on Science and Technology Education for All (Project 2000+) expect that these benefits be derived by the citizenry irrespective of gender, religious affiliation or creed.

At its meeting in 1992 in Dakar, African Ministers of Education concluded that the continent of Africa will make more rapid progress economically, socially and culturally if greater attention is given to the development of science and technology in the region. This position was endorsed by the Africa Regional Advisory Committee on the Renewal of Science and Technology. The Advisory Committee saw in science and technology investment, a potential for making Africa gain a leadership position in the world in science and technology enterprises.

The role of women in the attainment of this leadership position is deemed important on the count that about 40% of the population of Africa are females. Low participation of this significant group can appreciably slow down the pace of development of science and technology. Also, a scientifically

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and technologically literate female population will promote better child-rearing habits and home management practices that add up to the sound health of the citizens in the region.

Also, female literacy including literacy in science and technology has been shown to boost national per capital income, life expectancy and to reduce under-5 mortality rate. Data from UNESCO and UNICEF sources released in 1992 show a positive and significant correlation between female literacy and economic and social development of countries in Africa. It is anticipated that further boost will be given to economic and social development if girls and women are scientifically and technologically literate.

An awareness of the aforementioned benefits of a science and technology literate female population has stimulated interest in the education of girls in science. This awareness gained momentum in the early 1980s. The first task addressed was to determine the level of participation of girls in science and technology. Data reported in the 1988 World Digest of Statistics show that only 2% of those who were engaged in science and technology occupations in Africa are women. Yet, the women make up about 40 per cent of the population.

Unfortunately also, the inequity in the access and participation of girls relative to boys to science and technology is a matter of concern regarding the achievement of the Declaration of the 1990 World Conference and the goals of Project 2000+. Some statistics would be helpful in illustrating the point. For instance, between 1986 and 1989, the enrolment of girls for primary science trailed that of boys by 20 per cent in Sub-Saharan Africa. In 1988, seven out of the ten countries with the largest gender gaps in first level education were found to be located in Sub-Saharan Africa (Unicef, 1992). Gender gap between 40 and 49 per cent were recorded for Togo, Chad and Benin. Guinea-Bissau, Central African Republic, Morocco and Gambia had gender gaps between 21 and 32 per cent in primary science enrolment.

In 1989, the gender gap between students who were enrolled for science courses in secondary schools stood at 28.9 per cent in favour of boys. To add to the grim picture, data from the 1989 World Book of Statistics show that only 6.8 per cent of the scientists in Africa are women. Thus, emerging evidence has revealed a gap in the access and participation of females in science and technology in Africa. Although narrowing, this gap is still significantly wide and a matter for concern. The prime intention in this paper is to examine the factors that are associated with this gap.

TWO STRANDS OF EVIDENCE

Two strands of evidence relating to the under representation of women in science and technology in Africa are worthy of mention in this paper. Under representation is based on the concept of equity and proportionality. If 40 per cent of the population are females, the expectation is that the proportion of females in science and technology-related occupations should not be too far less of 40 per cent. The 6.8 per cent recorded for 1989 is, therefore, obviously below the mark. This provides the first strand of evidence.

The second strand of evidence is the proportion of girls within the schooling population that are enrolled for science. Eshiwani (1987) in Kenya, Bozimo (1991), Okeke (1989) and Agholor (1993) in Nigeria, have provided data to show that girls typically make up about 20 per cent of the class

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population in biology, about 10 per cent in chemistry and about 5 per cent in Physics in coeducational settings. In girls only institutions, less than 25 per cent of the final year class opt for science subjects.

MAJOR FACTORS IN THE UNDER-REPRESENTATION OF FEMALES IN AFRICA IN SCIENCE AND TECHNOLOGY

There is a wide range of factors which researchers like Okeke (1989) and Bozimo(1991) have identified as influencing the level of representation of women in science in Africa. These factors are largely school based. However, studies by Agholor (1991,1993) have shifted focus on socio-cultural barriers to access of females to science-related occupations. Taken together, these studies present a host of factors which for the purpose of this paper, are aggregated into five clusters: community, home, school, government and individual.

COMMUNITY RELATED FACTORS

The role expectation of the community plays a significant part in the choice of careers. Traditionally, the African woman is assigned the role of managing the home front while the man is out all day 'winning bread' for the family . While the man is occupied in the farm, in the carpenter's shop, as a bricklayer, road worker, gardener, blacksmith, goldsmith, tailor or driver, the woman is in or around the home engaged in domestic activities and petty trading.

Science and technology are seen as subjects which lead one to become an engineer, doctor, pharmacist, technologist or scientist working in a laboratory all day and all night long. Since these professions are of the 'stay-out-of-home' and strictly 'bread winning' type, women are hardly expected to undertake such careers as they are in opposition to their traditional roles in the community. As a consequence, few girls elect to study science with a view to taking up careers in science and technology related professions.

The African culture as Bajah and Bozimo (1989) note, is contributory towards the underrepresentation of women in science and technology from a community perspective. Women are expected to keep the home, cook and bear children. Formal school education is not considered necessary. Indeed, highly educated women are not regarded as good wives. The situation is worsened if a girl ventures into occupations in science and technology that are taken to be the preserve of males. It is considered more comfortable to settle for the 'feminine' vocations. Community perception of roles and careers in science and technology form the core of the views expressed by more than 30 African women scientists, technologists and mathematicians interviewed in 1989 by personnel from the Commonwealth Secretariat, London on their choice of career. More than 80 per cent of those interviewed identified community role expectations for women as a major impediment they had to tackle when the decision on career choice in science and technology was to be taken.

In the 60s and 70s, the factor of a non-science and technology career expectation for women in Africa was strong. In 1961, only 0.6 per cent of the scientists in Africa were women . In 1979, the women scientists made up 2.3 per cent of the pool of scientists. With an estimated 6.8 per cent in 1989, it would seem that the influence of this factor is becoming less intense. Perhaps however, other factors are emerging which are helping to boost the interest level of females in science and technology. Another community-related factor is the perception that science and technology are physically demanding

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endeavours. The belief is commonly held that a scientist or technologist engages in the use of heavy tools and physically taxing activities that women, the 'weaker vessels' are hardly cut out for. Even science teaching was considered to be more stressful for female teachers than the males (Okebukola & Jegede, 1991). Consequently, women are encouraged by members of the community to take to careers that match their physical capabilities, in most cases, non-science careers.

A phenomenon that plays a depressing role on the education of women in Africa is early marriage. This also influences science and technology education. Early marriage involves very young girls in their mid-teens, sometimes pre-pubertal being married under the coersion of parents to much older men. Although the incidence is decreasing and mostly limited to rural areas, it is still worthy of concern as recent reports show (see Unicef,1993). While early marriage is a notable feature of rural areas, early pregnancy while at school is a notable feature which keeps girls in urban areas out of school.

Girls who go into marriage early drop out of primary or junior secondary school. They, therefore, deny themselves the opportunity of education involving science and technology. Recent data from Nigeria (Unicef, 1992) show that early marriage accounts for over 50 per cent of the female dropout in primary schools. Since the boys are not affected by the early marriage phenomenon, or by early pregnancy while at school, they will therefore be more available in school for science and technology education. In terms of absolute number and proportion, the girls will be found to participate less in science classes.

Religion is also a noteworthy factor in the under-representation of women in science and technology. A number of religious inclinations in Africa do not favour activities involving mixed sex groupings. The women are not encouraged to engage in open interactions with men. In the science class, the girls are inhibited by religious beliefs to work with the boys. Since the boys are traditionally favoured to study science, the girls are denied the opportunity of gaining knowledge and skills from such mixed-sex interactions in the science class.

HOME RELATED FACTORS

Subject preferences and career aspirations as Mensah (1991) found, are stimulated largely by home influences. Parental career inclinations, sibling preferences and career distribution within the family are the recurring features of the home that the literature has shown as exerting influence on the subjects students select in school and the careers they ultimately go into.

In the home, boys (and hardly the girls) are called upon by the father to join in a hunting expedition or a visit to the farm. These engagements afford the boys the opportunity to explore nature and gain better understanding of the world 'out there'. Consequently, they end up gaining an early lead in science. They are also able to make mental connections of events described in the science class to what they saw in the farm or on the hunting grounds. The girls, having not had similar opportunities are inadvertently disadvantaged.

Also in the home, boys are encouraged to engage in activities that can kindle a spirit of fondness for science and can improve their scientific process skills. The boys, rather than the girls, play with catapult and they fly kites. The scientific principles of floatation, force, energy, friction, elasticity, projectiles, and laws of motion are thus learned early. While the girls congregate in the playground

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playing 'house', 'ten-ten', and singing songs, the boys are rolling tyres, making bows and arrows, constructing vehicles, playing football, wrestling or engaged in tug-of-war. As Okeke(1989) has shown, these activities that the boys are encouraged to undertake at home promote science learning thus giving them an edge over the girls. With time, this early lead is probably responsible for more boys than girls electing to study science and technology.

Another noteworthy influence of the home is the parental allocation of roles to children. Mothers expect their daughters not to fiddle with domestic appliances; the boys however can. The girls should carry babies on their backs, join their mother in the kitchen and remain largely in the background. Outspoken girls are said to be 'forward', a rather unsavoury remark. The spirit of inquiry that science promotes is hardly engendered by this setup. As a consequence, the girls end up not having a liking for science. Science is seen as a subject that features attributes that is not in agreement with their upbringing.

SCHOOL RELATED FACTORS

A number of school practices are implicated in the underrepresentation of girls in science and technology. Reports by Bozimo (1991) and Okeke (1987) have shown the existence of gender inequitable practices by male science teachers. These reports are in accord in their findings that male science teachers:

- generally suppress the participation of girls in science classes;
- ask the boys more frequently than the girls to answer questions or lead discussions;
- involve boys more in teacher-student demonstration activities; and
- encourage boys more than girls in project work.

These practices lead the girls to pick up the hint that science is probably more for boys than girls. This could be responsible for the girls 'shying away' from science resulting in less inclination to participate in science classes.

The erroneous impression that science and technology are meant for the boys is also conveyed in science and technology books. The technology books in use in Nigeria for example, carry diagrams featuring mainly males. So also are the biology, chemistry and physics books. Diagrams of people on the farm in agricultural science textbooks are men. Many exercies and worked examples in physics begin with 'A boy...' 'A man...' and hardly 'A girl...' or 'A woman...'.

Another school-related factor that is worthy of is the proportion of male science and technology teachers relative to females. No country in Africa from the BREDA (1990) statistics has female science teachers in absolute numbers at par with males. On the average, the gender gap is about 30 per cent in favour of males. Fewer female science teachers means fewer role models for the girls. More male science teachers could mean more classroom practices that will not favour the participation of girls. In all-girls schools, the inhibition for the male science teacher not to stay in school much longer after closing hours as commonly practised is not supportive of science learning for the girls.

The type of school is another factor of note. Evidence is available (see Agholor, 1993) to show that girls do better in science in all-girls schools than in coeducational institutions. The preponderance of coeducational institutions in Africa therefore means that fewer girls are likely to be available to take up careers in science and technology.

GOVERNMENT POLICY RELATED FACTORS

While research evidence points in favour of female teachers as models for encouraging girls to study science, the number of females employed as science teachers is few probably as a result of discriminatory practices. Women are not encouraged because of the practice of interrupting their service with maternity leave, absence from work to take care of sick children, the need to close early from work to take care of household chores and other family-care related breaks, leave and recesses.

In many countries in Africa, there are no written policies that discriminate against the employment of women. However, unwritten discriminatory mechanisms are instituted into the employment interview and selection processes to debar a number of women from being employed as science teachers. Thus, the issue of few qualified female science teachers exists on the one hand, while on the other, the situation is made worse by the lack of will of employers to hire female science teachers. It is gratifying to note however that this problem exists only on a minimal scale. Its existence is however considered worthy of mention in a discussion on factors hindering the participation of girls in science and technology in the Africa region.

Lack of incentives and special packages to encourage girls to study science is another factor that merits mention. Scholarships and special awards are hardly given to girls as extrinsic motivators for careers in science and technology. The recognition that many girls do not have the natural affinity for science is reason enough for such incentives to be institutionalised.

FACTOR OF PERCEPTION AND PREFERENCES

Girls in Africa also 'shy away' from science and technology for reasons that can be clustered together as perceptions and preferences. Reports from different parts of Africa [see for example Amara (1987) for Sierra Leone; Maranga (1987) for Kenya; Agholor (1991) for Nigeria] show that girls see science and technology as 'masculine' subjects. They (the girls) also see science and technology as difficult (Bozimo, 1991) and subject matter that boys are more intellectually capable of coping with. This perception is inhibitory of the desire to elect for science and technology subjects at school.

Preference for a subject as Mensah, (1991) notes is hinged largely on the anticipated potential for success in that subject. If the potential for success is high, the desire to study a subject is apt to be high (Eshiwani, 1987). Conversely if the learner perceives the chances of success in a subject to be low, the tendency is a diminished participation in that subject. This brings to the fore the factor of perception of performance in discussing the issue of female underrepresentation in science and technology in Africa.

Girls in African schools perceive their chances of success in science and technology classes to be low (Bajah and Bozimo, 1989). This may be a reason for the low level of participation or underrepresentation in the science and technology enterprise. The low expectation for success is hinged largely on data which show that girls do not do as well as the boys in science and technology (Euler-Ajayi, 1989).

The findings of Adigwe (1992) also show that girls, relative to boys, perform less well in problem solving in science. Females Adigwe (1992) notes, perceive problem solving in science and technology as 'unfeminine and as such men are supposed to be superior in these tasks'. Further evidence is provided by Bajah and Bozimo (1989) and Agholor (1993). While Bajah and Bozimo (1989) present

evidence indicating that Biology, Chemistry, Physics and Mathematics are less popular among the girls than the boys in Nigeria, Agholor (1993) provide statistical evidence on enrolment for and performance of girls in external examinations as well as enrolment for science-based courses in universities.

Available statistics in Nigeria according to Agholor (1993) reveal glaringly the low response rate of girls and women in STM education and other science related fields of human endeavour. The enrolment figures for boys and girls in the West African School Certificate (WASC) show that female enrolment is low in all the science and mathematics. Relative to ther boys, the girls perform lower in the sciences.

A close look at the 1987/88 undergraduate students enrolment for the Universities of Ibadan, Rivers State University of Science and Technology and Ahmadu Bello University reveal similar trend of low percentage of female enrolment in STM subjects.

The awareness of these data make the girls believe that they cannot do as well as the boys. This self-defeating posture is a strong factor which accounts for the lack of will of girls to include science subjects among those to be taken in the Senior School Certificate Examination.

INTERVENTION AND CONCLUSION

Having identifed clusters of factors that are implicated in the underrepresentation of women in science and technology in Africa, it is expedient to suggest strategies for reversing the trend. Several strategies have been tried out in different African countries with a great deal of success.

Role modelling and attitude changing techniques have been shown by Bozimo (1991) to significantly foster the interest and achievement of girls in science. Unicef (1992) also provide data to support the positive effects of hiring female teachers, the development of gender-inclusive curricula and 'gender'neutral' environments on the motivational level of girls in mathematics and science classes. Unicef (1992) further prescribes that diagnostic studies to identify specific cultural and other issues constraining the participation of girls in science should be conducted. On the basis of the findings, planners can design flexible programmes that can accommodate the needs and concerns of girls in science and technology.

The findings of a UNESCO commissioned survey reported by Aghenta (1989) recommends, among other things that

- sponsorship should be given to girls and women pursuing courses in science and technology;
- special science secondary schools should be established for girls;
- the science curriculum should be reorganised to include more content that is relevant to women;
- general awareness of the public should be raised to the issue of access of girls and women to science, technology and mathematics.

Bajah and Bozimo (1989) prescribe the creation of interest groups in science and technology for women. The activities of such interest groups it is believed, would help to promote the interest and favourable attitude of girls to science and technology.

The major focus of this paper is to identify factors that are responsible for the underrepresentation

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of women in science and technology in Africa. Factors falling under five clusters were identified. These are community-related, home-related, school-related, government influence and students' perceptions and preferences. There are obviously many more factors than have been mentioned in this paper that could explain the low participation of women in science and technology in Africa. However, those described are considered paramount as they are the recurring issues in the literature on the subject from the Africa region.

The trend towards improved participation of girls in science and technology withing the last five years is in the desired direction. If this trend continues and possibly accelerated through the implementation of the recommendations suggested above, the issue of gender inequity in science and technology in Africa may be an issue of the past by the middle of the 21st Century.

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A BILINGUAL SCIENCE INTERVENTION MODEL

Dr. Judith A. Bazler

Project METAS (Math Enriched Teaching Applied Science) a été conçu pour promouvoir les études des étudiantes et étudiants qui ne possèdent pas une bonne maîtrise de l'anglais, au niveau de l'école intermédiaire, dans les programmes de mathématiques et de sciences. Dans la deuxième année du programme, les étudiantes et étudiants de deuxième cycle ont remplacé la professeure ou le professeur de sciences de l'université. Le modèle pédagogique qui en est ressorti a mené à des changements permanents au sein du programme. Grâce aux efforts et à l'excellence des professeures et professeurs de sciences de la Lehigh University et des éducatrices et éducateurs de la Bethlehem (Pennsylvania, É.-U.) Area School District (BASD), une expérience communautaire scientifique pratique, sans manuel, a pu prendre place. Les objectifs étaient de développer des concepts scientifiques spécifiques ayant recours aux aptitudes mathématiques de base pour fournir des activités visant à rehausser les concepts du soi, développer l'habileté motrice et fournir un environnement qui contribuerait à motiver et à encourager les étudiantes et les étudiants. METAS a été conçu en tant que modèle bilingue avec des instructrices et instructeurs anglophones et espagnols formés par les étudiantes et étudiants du deuxième cycle de la Lehigh University. Pour optimiser la diversité, un nombre égal d'instructrices et instructeurs et d'étudiantes et étudiants de deuxième cycle ont participé, dont 4 parlant parfaitement l'espagnol.

Les résultats ont révélé que l'approche pédagogique comportant activités pratiques et travail d'équipe permettait non seulement d'accroître la quantité des renseignements scientifiques emmagasinés, mais aussi de modifier les attitudes des étudiantes et étudiants vis-à-vis des sciences. En particulier, ce changement d'attitudes était dû à un contact direct avec les étudiantes et étudiants de deuxième cycle, dont l'âge presque similaire à celui des étudiantes et étudiants qui ne possèdent pas une bonne maîtrise de l'anglais a permis d'obtenir de meilleurs résultats. De par son approche enrichissante dans le contexte culturel des étudiantes et étudiants, ce programme s'est révélé être un grand succès, tout comme d'autres programmes similaires offerts dans d'autres endroits.

A BILINGUAL SCIENCE INTERVENTION MODEL

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ABSTRACT

Project METAS (Math Enriched Teaching Applied Science) was designed to enhance the studies of limited English proficient (LEP) students at the middle school level in math and science. In its second year, graduate students replaced the university science educator. The resulting instructional model has led to permanent changes in the program. Through the efforts of Lehigh University professional science educators and Bethlehem (Pennsylvania, USA) Area School District (BASD) educators, a hands-on, nontextbook, community involved science experience took place. The goals were to develop specific science concepts utilizing basic mathematics skills to provide activities to enhance self concepts, develop motor skills, and provide an environment to motivate and encourage students. METAS was designed as a bilingual model with English and Spanish instructors trained by Lehigh graduate students. To optimize diversity, an equal amount of male and female instructors and graduate students participated, 4 of whom spoke Spanish fluently.

Results indicated that a hands-on, cooperative activity approach to teaching not only increased the amount of science context learned, but also changed attitudes of students toward science. In particular, this attitude change was due to direct contact with graduate students, whose closeness in age to the LEP students led to improved outcome and content area knowledge. By offering this enrichment program within the students cultural context, this program was able to achieve great success as have similar programs elsewhere.

INTRODUCTION

Project Success, (Shore, Rima, et al., 1980-1981), was a bilingual education and college career orientation program for Spanish-speaking and Asian high school students of limited English proficiency. It provided sources in English as a

second language including bilingual math, social studies, and science. Students performed extremely well on tests of English syntax. The program attendance rate also was better than the schoolwide attendance rate. Student attitudes toward the program were positive and the report recommended program expansion.

In another program gifted Haitian students of limited English proficiency were assisted in the acquisition of second language proficiency while developing their academic skills to prepare them for mainstream honors classes. Evaluation showed that the "program improved participants attendance and attitudes toward school; participants mastered English syntax objectives at rates exceeding the program goals; and program attendance generally exceeded schoolwide attendance" (Shore, Rima, et al., 1981, p. 31).

In the program Language through Science: An Integrated Model, Penfield and Urnstein-Galcia (1981) stated, "two main factors are involved in bilingual-bicultural education as far as science education is concerned: Interplay between language and concept formation and the need for culturally familiar examples in science material for bilingual students." The paper suggested that:

> an inquiry approach to science instruction with the proper hands-on activity, could improve the bilingual-bicultural program by focusing more on cognitive operations and problem solving, improving language skills in both languages and providing better opportunities for bilinguals to participate in advanced science studies. (p. 14).

Another program for bilingual children illustrated ways in which science activities utilizing culturally familiar materials can help bilingual students gain insight into the scientific concepts underlying the functioning of cultural

artifacts and tools. It specifically indicated how categories of material familiar to the students' cultures can be used in science instruction (Yao & Aula, 1979).

Mason and Barba (1992) felt that teachers should address the needs of bicultural science learners despite the shortage of instructional materials and qualified teaching personnel. The use of students' native language in presenting science-related ideas enhances their ability to grasp scientific concepts.

METAS was similar to these programs because, like them, this program did not negate the students' cultures but rather integrated them into their studies. Through this format the program was able to optimize results. By using the hands-on method, METAS, like the other successful programs described above, was able to reach the students more effectively and teach them better.

Only one program, dealing with the education of the Pueblo Indians, failed because it tried to remove the students' culture from their studies. Suina-Lowery (1979) observed:

> Federal and state bilingual education legislation since 1923, has not enhanced the education of Pueblo Indian children in New Mexico. Lacking public school control, Pueblo Indians have resisted the establishment of bilingual education programs for their children. Bilingual-Bicultural development must be preceded by giving Pueblos community control. (p. 23-27).

THE PROJECT

Project METAS (Math Enrichment and Teaching Applied Science) was designed by a Lehigh University professional science educator and Bethlehem Area School District (BASD) educators to provide limited English proficient (LEP) students at the middle school level with intensive math and science

enrichment. The program, funded for its second year by the Pennsylvania Department of Education, was a hands-on, nontextbook, community involved science experience. METAS sought to develop specific science concepts utilizing basic mathematics skills, provide activities to enhance self concepts, develop motor skills, and provide an environment to motivate and encourage students. The program was designed as a bilingual model where students were provided with instruction in both English and Spanish. Specifically students studied concepts of acid-base, nutrition, geology, polymers, and biology. Special concerns were given to instrumentation, application, scientific methodology, and safety.

Students were taught by trained Lehigh graduate students on Tuesdays and Wednesdays. Tuesday's sessions were held at Broughal Middle School in anticipation of the Lehigh University experience on Wednesdays. The other 3 days were taught by the BASD team of educators at Broughal Middle School. Two of the Lehigh graduate students were Hispanic and proficient in Spanish. To optimize diversity, equal numbers of female and male graduate students were chosen.

EVALUATION

Since this project's goals were to generate positive attitudes and to increase knowledge of science, three types of methods were used by the teachers to evaluate the program's effectiveness. The design of the evaluation was based on a qualitative triangulation concept. That is, each source of information was verified, whenever possible, by utilizing two or more techniques.

Every student was given a content area exam before and after being taught. The six content areas were safety, acid-base (pH), nutrition, polymers, geology, and biology. In

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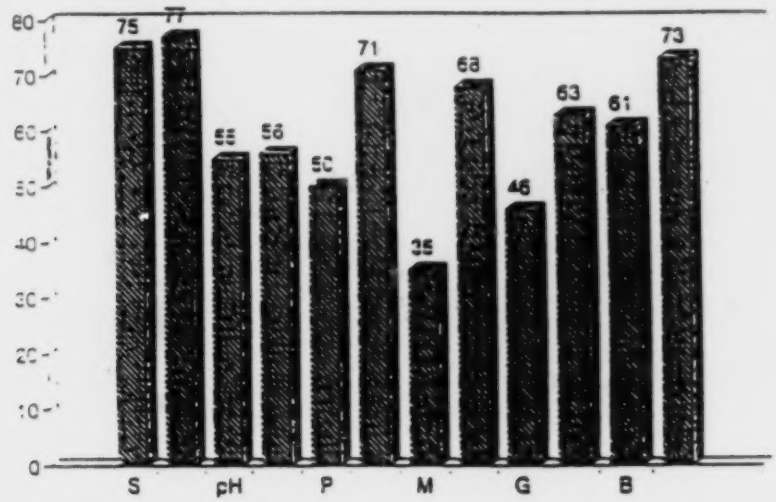
addition each student was asked to keep journal entries before and after each Lehigh University experience. Students were taught before and after the Lehigh experience at Broughal Middle school by Bethlehem Area educators. Curriculum for the 5 weeks was developed by Dr. Bazler. Each student also was given a pre- post- attitude assessment questionnaire. Dr. Bazler designed and analyzed all evaluation data. Information from each of the above sources was analyzed using procedures such as content analysis and descriptive statistics (see next section). The results reflect information gathered from all major stakeholders.

RESULTS

Content knowledge increased by 19% for all students in all areas. The student percentile rank figures for both pre- and post- evaluation are reported in Table 1.

TABLE 1

Average Student Performance on Science Pre- and Post- Tests



S=Safety, P=Polymers, M=Nutrition, G=Geology, B=Biology
Left Column=Pre-Test, Right Column=Post-Test

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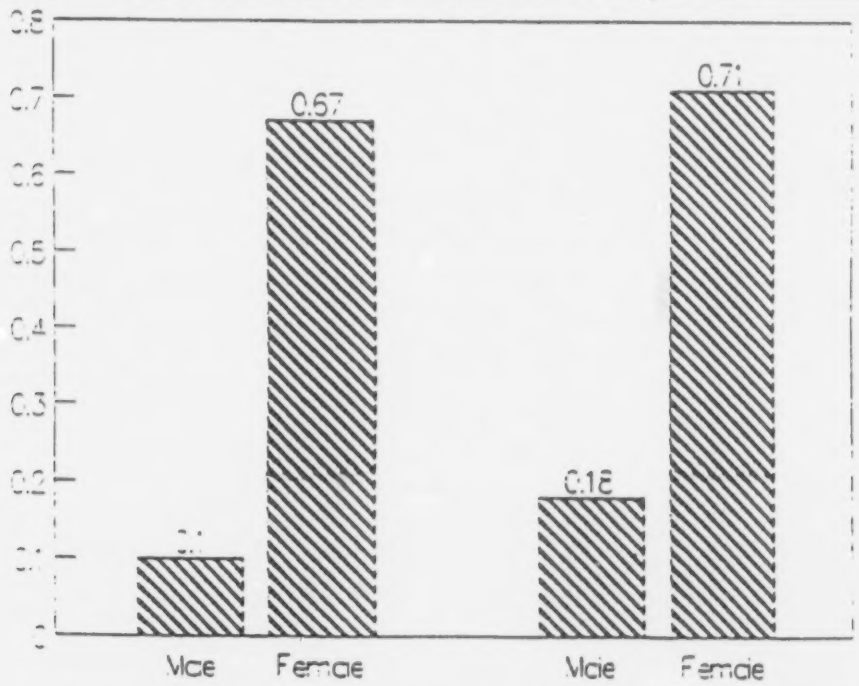
The most noticeable gain was in the area of nutrition with an overall increase of 33%. Students also seemed to enter the program knowing the least about nutrition.

Student Pre- and Post- Questionnaire. A science attitudinal analysis was administered to all students by the teachers before and after their participation in the program. The instrument required students to draw a picture of, name, and list six adjectives describing a scientist. A total of 48% of the children drew male scientists prior to their teacher's experience and 52% drew male scientists after the experience. An increase of 4% of the children drew female scientists after the teachers had participated in METAS (see Table 2). The most recorded adjective both prior to the experience and after was "intelligent."

TABLE 2

Student Attitude Analysis

Percentage of Female Pictures Drawn (Pre- and Post-Test)



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JOURNALS

Student journals confirmed the attitude evaluation results. After the program, students thought of science as fun and indicated they had been anxious prior to the Lehigh University experience. One student "did something different from the rest of her class and worked on shampoos to determine which of them had acid or base." A lot of the students wrote about questions the laboratory activities stimulated, such as wondering about how much acid would be in a particular shampoo.

Most students commented on how much fun they had. "I had more fun than any other field trip I have been to from school. I even saw things that I have never seen before. Yesterday was so much fun because of all the activities we did. I wish we could go every single day (to Lehigh Labs)." Kristen concluded that "I liked the Scavenger Hunt at Lehigh University. We had a partner and a net. We had to feed a bug, sneak up to it, and cover it with a net. We then put it in a box. I caught a spider with long legs and a lightning bug. After that we looked at them through microscopes. I enjoyed it very much."

Nicole commented, "I went to Lehigh and blew bubbles with a straw into a plate filled with dishwashing liquid. My partner and I blew many bubbles. Another thing we did was a scavenger hunt on the edges of the woods. I caught a moth and a big grasshopper. It was worth joining Project METAS because it's fun and learning at the same time. METAS is the best!"

DISCUSSION

These results indicate that a hands-on, cooperative, activity approach to teaching, utilizing graduate students, not only increases the amount of science content learned but also changes attitudes toward science. The perception of one of the Lehigh graduate students, shown here, sums up the impact of

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METAS:

"It was perhaps with a note of hesitancy that I first embarked on my tour with METAS. Nevertheless, I enthusiastically took the job and left my cozy home in Boston for 5 weeks in Bethlehem. And after all is said and done, I am really glad that I chose to do it. I guess my fondest memory of the entire experience was the enthusiasm of the kids. I must confess that a part of my hesitancy in the beginning was an inability to believe that 6th, 7th, and 8th grade kids would willingly give up their summer of pleasure for a summer of school. I could not convince myself to take part in what I saw as summer incarceration.

"These doubts quickly vanished when I first met the kids. There were no tortured faces (or at least very few), only the smiles of children truly happy to be learning. Each week proved to be more rewarding than the week before, and as the end approached I was a bit surprised to find myself sad that it had to end. I guess the kid in me who wanted to play all summer had been taught a very important lesson by the kids in METAS: school can be fun, both for the kids and for the teachers. Yet even more important, after spending 5 weeks with the kids their enthusiasm gave me hope, hope that through the achievements of a group of very special kids - be it in science or in literature - the world can be a better place.

"One of my objectives in participating in METAS was to sharp my knowledge and develop the interest of all students for science. It's rewarding when you see that you are reaching your objective. This program has been very important to me, to see how the students' interest increased and how they learned, some faster than others, but the most important fact is that all learned more about science. It's nice to hear at the end

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of the day, 'I'm going to be a scientist.' This program has been a beautiful experience for me. Thank you."

These outcomes are significant because, unlike learning situations in which a significant age difference exists between teacher and student the closeness engendered mutual learning opportunities. The positive interaction between middle school students and the graduate students who taught them led several of the latter to reevaluate their career choices. Not all of the graduate students were initially education majors, but - changed their career path after METAS participation.

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THE JASON PROJECT EXPERIENCE AND ATTITUDES TOWARD SCIENCE AS AN ENTERPRISE AND CAREER
Phase II

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La technologie des télécommunications de pointe, soutenue par du matériel de programmes d'études écrit, a été utilisée pour montrer une série d'explorations sous-marines aux étudiantes et étudiants de classes de la 4e à la 12e années d'écoles américaines et canadiennes (le projet JASON). Ce projet avait pour but d'éveiller l'intérêt des étudiantes et étudiants et du personnel enseignant à l'égard des sciences et d'encourager les étudiantes et étudiants à poursuivre une carrière dans ce domaine. Des données pré-test et post-test sur les attitudes des 367 participants et des 339 participantes à l'égard des sciences ont été recueillies dans un endroit spécifique. Ces données reflètent des changements d'attitude significatifs pré-post-test tant parmi les étudiantes que parmi les étudiants qui ont participé au projet JASON. Une évaluation de deuxième étape actuellement en cours étend ces conclusions préliminaires à un groupe témoin neutre et établit la réaction de la classe, les aspirations professionnelles des élèves et leur style d'apprentissage.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

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Phase II

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ABSTRACT

Advanced telecommunications technology, supported by written curriculum materials, was used to broadcast a series of undersea explorations for observation by students (Grades 4-12) across the U.S. and Canada (The JASON Project). The goal of this project was to enhance science interest among students and their teachers, and to inspire students to pursue science careers. Pre- and post-test data on participant attitudes toward science from 367 male and 339 female students were collected at one downlink site. These data reflect significant pre- post-gains in attitudes toward science among both male and female JASON participants. A second phase evaluation already underway extends these preliminary findings using a no-treatment control group, and measures of classroom response, student occupational aspirations, and student learning style.

INTRODUCTION

Considerable documentation exists on the recent decline in science interest among high school students (Dresselhaus, 1984); Thomas, 1986), and of the effects of science course deselection during the high school years on retention in the science career pipeline (Betz, 1990; Fox, 1979). Further, the shift from science to non-science careers during the college years has been well documented (Astin & Panos, 1969). Despite this overall decline in science interests, and the importance of the implications of this decline, few direct attempts have been made to heighten scientific interests or to study how science interests form. As a result, we know very little about

the psychological processes involved in the selection of science careers.

The JASON Project is a five-year program of undersea exploration which utilizes a sophisticated network of telecommunications technology, to provide live telecasts from remote sites enabling students to observe and participate in the process of scientific discovery as it occurs. The JASON Projects seeks to improve science attitudes of teachers and students in Grades 4-12 through "telepresence", the use of telecommunication technology to create a simulated presence at a remote site. This experience is enhanced by a special curriculum emphasizing hands-on learning designed by the National Science Teachers Association (NSTA). One goal of the JASON Project is to inspire students to pursue scientific careers.

Twelve science museums across the country participated in the 1989 project via satellite link-up with the command ship, Star Hercules, in the Mediterranean Sea. JASON, the robotic, camera-equipped vehicle explored a 1600-year old Roman shipwreck, and documented the first known hydrothermal vents in the Mediterranean. Simultaneously, thousands of school children attending the live transmissions at the twelve museum sites across the country shared the excitement of these discoveries with Dr. Robert Ballard and his team of scientists. In the second JASON expedition, 150,000 students from the United States and Canada explored the sunken Battle of 1812 warships, Hamilton and Scourge, at the bottom of Lake Ontario through telepresence.

To enhance the educational impact of the JASON Project the National Science Teachers Association (NSTA) developed a special curriculum for Grades 4-12 for each of the JASON

expeditions. This curriculum featured hands-on activities dealing with technology, physics, biology, geology, history, and social studies, including the specific technologies that make telepresence possible -- i.e., robotics, satellite communications, and sonar exploration. Participating teachers were trained in the use of the curriculum during an in-service training workshop held several months prior to the JASON telecast.

An intensive, exploratory outcome study was undertaken at one downlink site (Lehigh University) to assess the impact of the multichannel JASON Telepresence experience on student and teacher attitudes toward science (Bazler, & Spokane, Ballard, & Fugate, in press). This study is being followed by a phase II evaluation employing a no-treatment control group and expended outcome and learning process measures.

Results of the Preliminary Evaluation

Pre- post- changes. Two-tailed t tests were used to compare pre- and post-test scores on the two outcome measures for students and teachers. On the 72 item science attitudes scale, there was a significant pre- post- difference (t = 2.05, p <.04), and a nonsignificant change of the 14 item SD scale (t = 1.88, p <.06). Figure 1 present the post-test JASON Project evaluation data by student grade. An unexpected curvelinear relationship was found between student grade and post-test impressions of science as an enterprise.

The preliminary study confirmed our belief that science attitudes are a complex blend of emotional reactions and intentional attitudes. It is apparent that positive outcomes in both of these attitudinal domains are associated with the JASON experience. The complex factor structures found in this study, however, suggest that we can no longer presume that

simple interventions to enhance science attitudes will have universal linear effects. The various emotional and attitudinal components of science attitudes may be differentially affected by specific elements of interventions such as the live Telepresence broadcast of the curriculum component of the JASON experience.

There were no significant overall differences between male and female JASON participants in the gains received -- a finding which is contrary to some widely held views about the attractiveness of science to women. We were heartened but the finding that young women no longer consider science to be a male domain, but concerned that most young men may not share that belief. Male reactions to women entering science may be as crucial to those womens' success as those womens' personal reactions. Attempts to influence science attitudes must include a combination of emotional and behavioral strategies if they are to be more universally effective.

Phase II Evaluation

The second phase of our evaluation is a controlled pre-post evaluation using a national rather than a local sample.

Sampling. An equal distribution of students in Grades 4 through 12 will be sampled from 3 geographically diverse project sites. Approximate sample size will be 1200 students representing 60 classrooms. Sampling techniques will provide representation of women and minority groups sufficient for analysis of these variables. A control sample, matched at the classroom level, will be solicited from participating school districts. All teachers whose class rooms are in the student segment of the evaluation will be included in the teacher evaluation.

Instruments. Teacher participants will complete a brief

demographic form, an 11 item semantic differential indicator of attitudes toward science, an information processing styles inventory, and the science attitudes scale (see Bazler et al., in press for a complete description of these instruments). The newly included ISI is a 17 item version of a Likert-scaled measure of individual styles used in processing information developed by Berzonsky (1991). Internal reliability coefficient (alpha) range from .62 to .78. Average ISI test-retest reliability ranges from .71-.78. The ISI provides scores for 3 styles of information processing -- informational, normative, and diffuse. Teachers will also maintain a log of their use of the JASON curriculum materials and students's reactions to them.

Student participants (pre and post) will complete a brief demographic form, and the full set of outcome measures. In addition, students will complete an occupational aspiration measure derived from Holland's occupational theory (Spokane, Collier, & Campbell, 1993).

Procedures. Teachers were solicited at the sites during the training session, and were offered a $50.00 honorarium for their participation. Each teacher was then sent a packet of materials containing the study materials prior to receiving the JASON curriculum. Post-test measure will be administered at the home school following the telepresence experience. A 20% subsample will complete a mid-project questionnaire prior to the telepresence experience in an attempt to isolate the influence of the curriculum from that of the telepresence experience.

Planned Analyses

Multivariate analysis of covariance will be used to examine pre-post control group differences on each of the

outcome measures. Additional analyses will examine information processing style in relation to gain, and attempt to analyze the relative effects of the telepresence and curriculum components on student attitudes (Demers & Shrigley, 1990). These analyses should further clarify the influence of the JASON Project experience on science attitudes and intentions to pursue science careers.

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The complete set of means, standard deviations, factor loadings, and F tables is available from Arnold R. Spokane, 233-A Iacocca Hall, Lehigh University, 111 Research Drive, Bethlehem, PA 18015.

APEO INITIATIVE ENCOURAGING GIRLS TO KEEP MATHS & SCIENCES THROUGH HIGH SCHOOL

Erica Belling, Julia Biedermann and Debra Fletcher

L'Association of Professional Engineers of Ontario (APEO) examine actuellement, par le biais d'un certain nombre d'initiatives, le problème du faible pourcentage de femmes qui se lancent dans une carrière de génie. Une de ces initiatives consiste en une bande vidéo destinée aux étudiantes et étudiants de septième et huitième années. Son message : demeurer ouvert(e) quant à ses perspectives de carrière en continuant d'étudier les mathématiques et les sciences à l'école secondaire. Des études ont démontré que beaucoup de filles de premières années d'études secondaires abandonnaient les cours de mathématiques et de sciences nécessaires pour poursuivre des études de génie. Il est essentiel d'approcher les jeunes filles avant qu'elles n'arrivent à l'école secondaire pour les persuader de continuer d'étudier les mathématiques et les sciences à l'école secondaire. Elles pourront ainsi se qualifier à des cours de génie et envisager des carrières dans ce domaine après avoir obtenu leur diplôme d'études secondaires.

Ce document traite de la recherche et du développement de cette bande vidéo sur les carrières non traditionnelle destinée aux étudiantes et étudiants des classes de septième et huitième années, et de l'impact qu'elle a eu dans les écoles ontariennes depuis sa première diffusion en mars 1992.

APEO INITIATIVE ENCOURAGING GIRLS TO KEEP MATHS & SCIENCES THROUGH HIGH SCHOOL

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ABSTRACT

The Association of Professional Engineers of Ontario (APEO) is currently addressing the low percentage of women choosing engineering as a career through a number of initiatives. One of these initiatives is a video aimed at students in grades seven and eight, with the message to keep your career options open by keeping up with maths and sciences in high school. Research has indicated that many girls drop the necessary high school math and science courses required for engineering in the early high school years. It is necessary to approach girls before they get to high school, in order to persuade them to continue taking math and science courses through high school. This will ensure that young women are qualified to enter engineering, and can consider it as a career when they reach high school graduation.

This paper discusses the research and development of this nontraditional video for grades seven and eight, and the response and impact it has had in Ontario schools since its release in March 1992.

Introduction

The Association of Professional Engineers of Ontario (APEO) is the regulating body for the engineering profession in the province of Ontario. The APEO is concerned about the low percentage of women choosing engineering as a career, as compared to other historically male-dominated professions such as medicine and law. In 1989, of the bachelor degree graduates in Canada in engineering, only 13% were women, while in medicine, 45% were

women, and in law 48% were women.[1] In 1991, the APEO initiated a *Proactive Program for Women in Engineering* with the following objectives:

(1) Encourage more women to enter the engineering profession,

(2) Eliminate sexist attitudes in the profession,

(3) Achieve greater gender balance in the profession,

(4) Make the "P.Eng" designation a sought-after status by women engineers.

Much of the work of the Association of Professional Engineers of Ontario is done through volunteers from its membership, who serve on committees, such as the Women in Engineering Advisory Committee (WEAC). The Women in Engineering Advisory Committee of the APEO has a mandate to address the issues and concerns of women in engineering.

Background

A Video Task Group (VTG)[2] was formed of WEAC members and APEO staff and charged with the task of supervising the design and production of a video to encourage girls to pursue a career in engineering. Initial research found that many girls make the decision to drop math and science courses as soon as they can (i.e. in grade 10). In doing so they inadvertently exclude themselves from a wide range of careers, including engineering. The initial target audience was girls aged 12-14 in hopes of convincing them to continue with math and science courses as a way to get into a rewarding career in engineering.

The VTG reviewed the available audio-visual materials and found they were mostly out of date or inappropriate for the target audience. It was decided that a short, entertaining and stimulating video was needed. The approach would be non-traditional and fresh. Consequently, the resulting video would have a shelf life of only about five years.

Research on the Audience: Girls 12-14 years old

The APEO contracted with the North Bend Film Company for script research and development, and production of the video. Their initial research was aimed at answering the question "Why do girls aged 12-14 decide to drop out of math and science?" Consequently, they planned to interview girls in this age group to determine why they had decided to either drop or continue with high school math and science courses. Prior to these interviews a storyline for the video had already taken shape. It involved having a young female engineer relating her career choice, through anecdotes, to an audience of 12-14 year old girls. This storyline was reviewed by the VTG and the lead character's age was dropped dramatically from a 30-34 year old engineer to a 21-24 year old recent engineering graduate. The girls interviewed would also be asked for their opinions on the storyline and the lead character.

The interviews conducted with the target group were very revealing and resulted in major changes to the slant which the video was going to take. The target audience was narrowed to grade 7 and 8 girls who have not committed themselves to studying math and science courses throughout their high school years. Conversations with test audience members made it very clear that somebody aged 21-24 is still too old to identify with. The number one concern of the girls in this age group was what lies immediately ahead; that being senior high school. After that, being cool, being popular, and generally surviving were of utmost importance.

The lead character had to be someone the target audience wants to hear from and can identify with. She needed to be someone who has been through it recently herself and she must be pretty, bright and popular. She has to be the kind of girl that most of the members of the target audience aspire to be when they are 18.

Design of an Effective Video

Clearly the original story line was inappropriate for this age group. The majority of the target audience were not ready to hear about a career in engineering as a means to convince them to maintain their math and sciences. They needed to be convinced of this in a more subtle way by identifying with the lead character and learning how to keep their options open through her experiences. The approach needed to be as positive as possible. This generation is already deluged with "just say no" campaigns; no to drugs, cigarettes, alcohol, etc. They need to hear what to say yes to!

A new storyline was embarked upon. Three professionals in the education field offered their comments and suggestions which further helped shape the video. They all suggested casting a multicultural girl as the lead character to better represent the changing population of Ontario high schools. Also, math and science courses should be portrayed as not being so difficult.

Anais Granofsky was chosen to play the lead role of Claire Kuzak. Anais fit the lead character requirements perfectly. She was someone the target audience could immediately identify with through her role in the TV series Degrassi High. She has a likable personality that comes across well on camera, she is of ethnic background, and she is attractive and bright.

The video "Claire Kuzak's High School Survival Guide" tells the story of how Claire, a popular high school student, realizes in grade 12 that she limited her career options by dropping maths and sciences back in grade 10. Claire's solution is two years of summer school maths and sciences "while everyone else is out having a blast". The main message of the video is keeping your options open and is exemplified in Claire's line "I want to be able to do what I want to do, when I figure out what it is I want to do".

An offbeat approach to shooting the video was taken as a means to further identify with the target audience. The storyline has the video being produced by Claire's younger brother as part of a school project. The camera angles are at times disorienting (to an adult) and the music and titles are upbeat and modern. The total package of storyline, lead character and camera shots result in a video which is perfectly suited to the target audience.

The video screens in 9 minutes and is intended to be used by engineers as a "lead in" to a discussion about engineering. A presentation guide was produced to help the presenter get the students talking about the video's message and careers in engineering. Included in the guide are typical student questions and answers, background information on grade 6, 7 and 8 student characteristics, and suggestions to how to transition from a discussion of the video to a discussion on engineering as a career.

Getting the Message Out To the Schools

In order to get the message of this video out to the schools, two copies were distributed to each of 42 chapters of the APEO located across Ontario. The Education Co-ordinators in these APEO chapters were responsible for ensuring that the video is available for use by APEO chapter members who do career presentations in their local schools.

It was found that there were many requests directly from education professionals for the video, so copies were made available for this purpose, through APEO headquarters in Toronto.

In addition, Industry, Science and Technology Canada acquired ten copies per province for use outside Ontario.

Response and Impact

The response from students and education professionals to the video presentation was evaluated through a follow-up telephone survey conducted by the APEO shortly after the video was presented in each class. As the video has only been available for ten months at the time of writing this paper, responses have been analyzed from only twenty-one classes. (Additional information will be presented at the GASAT 7 Conference in August 1993.) This sample of responses is not statistically significant. The responses provide qualitative information only. The first phase of the follow-up, response from education professionals, is partially completed. The second phase, response from engineering professionals, will be complete by August 1993.

The response from education professionals is based on requests for the video received by the APEO directly from teachers or guidance councillors. There were 17 responses representing 21 classes who viewed the video. (The discrepancy is due to single responses received from education professionals who presented the video to several classes.) The responses from each grade are summarized in Table 1. The responses were from grades 4 through 10 from areas across Ontario including Manitoulin, Toronto, Sudbury and Thousand Islands.

TABLE 1 : Number of Responses to Follow-up Survey by Grade

Grade	No. Responses
4	1
6	2
7	3
8	6
9	4
10	5
TOTAL	21

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The education professionals were asked to respond to the following four questions in the follow-up telephone survey:

1) Was the video effective in capturing the student's attention ?

There were 15 positive responses and 2 negative responses. Most responses indicated that the students enjoyed the technique which the video used. However, several commented that their classes found the technique distracting. Two comments were of some concern: teacher "felt that the boys would have preferred seeing a male student" and "boys felt that the video did not relate to them". In contrast, another teacher felt that the students picked up that the message "applies to both boys and girls". In summary, there was consensus that the video held the students attention.

2) Did the students get the message ? If not, why not? If yes, how do you know?

Most of the teachers who indicated that their students picked up the message were able to confirm this by subsequent discussion with the students: "message was clearly delivered"; "message was well summed up in final moments of video". In addition there were several suggestions concerning how the message could be presented more effectively: "felt that it could have been presented in a stronger fashion"; "video focused almost entirely on what you shouldn't do, until the very end";"disappointed that there was not more information on engineering". Finally, one teacher felt that the grade 9 students were "too young to relate to the message, students can't think past the end of the day let alone the end of high school".

3) Did the video provide a "lead-in" to talk about engineering?

The general response was that the video did <u>not</u> lead to a discussion of engineering. In most cases, engineering was discussed only if the teacher directed the discussion

towards engineering. The one exception was an immediate connection to engineering by the grade 4 class who had previously discussed engineering as a career. This response is not surprising as the video does not portray a career in engineering, and was intended to be used as an introduction to a presentation on engineering. The presenter's guide addresses this issue by providing specific suggestions to make the transition from a discussion of the video, to a discussion of a career in engineering. It appears that the presenters guide was not effective in this regard, or was not read.

4) What discussion was stimulated by the video?

Discussion appeared to focus on careers in general where math and science would be important, choices of courses, general importance of math and science, and finally keeping options open. In addition there were several specific comments: "Importance of some idea of what you would like to do in life"; "discussion centred around non-traditional careers for women". Finally, one teacher indicated that there had been no discussion and that students reluctantly answered questions.

The responses to the survey suggest that the education professional who facilitates the discussion with the students has a significant influence on the effectiveness of the message communicated by the video and the subsequent class discussion on engineering as a career. This is illustrated by the enthusiastic response from an education professional of the grade 4 class who immediately connected the message to keep maths and sciences with careers in engineering. In contrast, an education professional from a grade 9 class, responded unenthusiastically, that the students could not relate to the message and were not capable of thinking about careers.

It is difficult to evaluate the impact of this video on female students at this early stage. The impact is best measured by the change in the number of girls who continue to take maths and sciences in high school. Over the long term if this APEO initiative, along with the

initiatives of others is successful, there will be more women enrolled in engineering and other technology related fields.

Conclusion

Although the assessment of the response to this video is not yet complete, preliminary results indicate that the APEO has made a positive contribution in communicating to students the importance of keeping their career options open by keeping up with maths and science. In some cases, classes were able to make the connection between the video's message to keep maths and sciences, and a career in engineering. In a few instances, it generated discussion on non-traditional careers for women. A more thorough assessment will be made upon completion of phase two, when the follow-up survey results have been evaluated for class presentations facilitated by engineering professionals.

Organizations such as the APEO must continue working with education professionals to understand how we can assist them in encouraging girls to keep taking maths and sciences and consider careers in engineering.

NOTES

1. MORE THAN JUST NUMBERS, Report of the Canadian Committee on Women in Engineering, April 1992.
2. Video Task group members : Michael Ball, Mary Ann Crichton, Debra Dileo, Stephen Jack.

A FEMALE RELEVANT SCIENCE AND TECHNOLOGY

Kamala Chandrasekhar, Ph.D.

Le siècle dernier a connu des développements extraordinaires dans le secteur des sciences et de la technologie. Toutefois, ces développements ont aussi été à la source de la discrimination sexuelle. Les progrès technologiques ont été divisés en deux catégories : la «haute technologie» et la «technologie rudimentaire». Les hommes préfèrent la «haute technologie», ou technologie de pointe, pour sa «virtuosité», alors que les femmes s'en tiennent à la «technologie rudimentaire», parce qu'elles accordent plus d'importance aux valeurs pour l'utilisatrice ou l'utilisateur. D'autre part, la «haute technologie» prend de l'importance parce que c'est une activité qui favorise la création de richesses, alors que la «technologie rudimentaire», considérée comme une activité de services, est plus secondaire.

Alors que les pays développés marginalisent les activités des femmes en affirmant qu'elles appartiennent au secteur des «non-experts», l'Inde développe des technologies appropriées en vue d'un perfectionnement soutenu des femmes. Dans deux États du Sud de l'Inde, cette expérience a donné lieu à de formidables résultats, un grand nombre des technologies de pointe, telles que la biotechnologie, ont trouvé leur emploi dans la vie quotidienne des résidentes et résidents de villages sélectionnés dans ces deux États, Kerala et Tamil Nadu. Les femmes ont mis sur pied des industries à production restreinte et sont parvenues à l'indépendance financière. Leurs réalisations ont changé le village tout entier - le taux d'alphabétisme a grimpé jusqu'à près de 90 %. Les enfants de plusieurs familles travaillent et la pauvreté est presque éliminée.

L'après-guerre froide freine le libre échange des connaissances technologiques pour le développement humain. Dans de telles circonstances, la meilleure façon est de dépendre de technologies mises au point par les indigènes, qui permettent d'éliminer la pauvreté et la famine et assurent le développement intégré des femmes. L'Inde a refermé l'écart entre la «haute technologie» et la «technologie rudimentaire» et l'a fait dans une harmonie totale.

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A FEMALE RELEVANT SCIENCE AND TECHNOLOGY

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ABSTRACT

Last century saw spectacular developments in science and technology. But it was the cause of gender discrimination. Technological developments became grouped into "high-tech" and "lo-tech". Men preferred "high-tech" for its 'virtuosity' value whereas, women preferred "lo-tech" as they attached more importance to user values. Further "high-tech" gets importance as wealth creating activity while "lo-tech" is given a subsidiary position as service activity.

While the developed countries are marginalising women's activities as belonging to the 'non-expert' sector, India is developing appropriate technologies for the sustained development of women. In two of the States in the South, this experiment has brought in tremendous development, many of the 'high-tech' technologies like bio-technology have found their way into the every day life of the people in selected villages in the two states, Kerala and Tamil Nadu. The women have developed small scale industries like power-looms and are able to stand on their own. This has changed the face of the whole village - per centage of literacy has gone up to nearly 90%. Several families have their youth employed and poverty is nearly eliminated.

The post-cold war era is hindering free flow of technological knowledge for human development. Under such circumstances, the best way is to depend on indigenously developed technologies that would eliminate poverty and hunger and provide sustainable development to women. India has thus bridged the gap between 'high-tech' and 'lo-tech' and that too in a harmonious way.

BODY OF PAPER

The last century saw spectacular developments in Science and its off-shoot technology. Putting men on the moon, the Russian and the American spaceships docking in the no man's land, the cosmonauts exchanging pleasantries in the vast blue space and so on. But these

developments are responsible for making one half of the world's population, the women, unhappy. Gender equity has become a casuality. This is a common occurrence all over the world but the depth and the breadth differs in different parts of the world and with different people. A kind of stratification is also evident.

Pacey, Arnold (1983) has brought it out very clearly that the organisational strategies women describe are culturally devalued because they are 'lo-tech' in contrast to the 'hi-tech' solutions male-dominated organisations seem to prefer. Further, women, because of their responsibilities for other people, tend to emphasize user or need based values, whereas, men tend to emphasize "virtuosity" values. It being "hi-tech" gets carried. On the other hand, the importance of women's work is not recognised because of the habit of regarding women's role as service activity, subsidiary to the more serious aspect of wealth creating activity of men.

These can be illustrated by taking examples from, my own country, India. In one of the southern states, Kerala, the Government attaches less values to economics and economic values. On the other hand, user and basic needs carry more weight. The state's agricultural development during the last 20 years has been nutrition-oriented output. In this state, women play a greater role in the user sphere. It would be appropriate here to quote Pacey, Arnold (1983) who said, "Economists can certainly tell us what it would cost to put a man on the moon but they cannot say whether that was worth it. That is judged on a different basis, and according to 'virtuosity' values".

The age old tradition of historically excluding women from craft apprenticeship, industrial labour and managerial ranks of bureaucratic organisations is becoming pronounced with the advent of technocratic organisations and polarisation of technical skills into "expert" and "non-expert" sectors (Burris, 1989). According to studies conducted

by Machung (1984) and National Research Council (1986) and others in 1980, 92.4% data entry operators; 91.2% bank tellers and 91% telephone operators were females. Recent studies in UK and other places show that women are in the majority in "non-expert" production jobs such as "stuffing boards" whereas 94% of technicians; 94% of craft workers and 97% of managers are men (Cockburn 1985).

When in the highly technically advanced countries women are being marginalised in the technical sectors under the pretext of either "high-tech" or "lo-tech" and "expert" and "non-expert" bifurcations, in India there is strong move to "demystify" technology and bring it in a simpler form to the rural poor (Indrajit, Day 1989). According to him even frontline areas of science and high technology have ample scope for application in the development of rural areas - bio-technology, space technology, information technology and so on.

India is a country where 76% of its population lives in villages. Out of this a sizable per centage is illiterate and another big chunk is below the poverty line (BPL). If these villages are to be developed and basic amenities are to reach them, technology in its simplest form should reach them. The search should be to find out simple technologies that could enable them to utilise indigenous materials for the benefit of these unfortunate people. That sophistication and creativity are separate entities, is to be realised if advanced technology is to reach Indian villages and benefit them.

It is heartening to know that Indian scientists and technologists have realised this and have brought about the harmonious development of a village in the Tamil Nadu state. The name of the village is Kundrakudi. Population of this village is around 3000. Most of them are below the poverty line. Scientists and technologists from the nearby Central Electrochemical Research Institute (CECRI) took it as a challenge to develop this village through identification and use of appropriate

indigenous technologies for the fullest use of natural as well as human resources of the village. This helps develop skills in community services in the following areas. Mostly they were women : water shed survey; water prospecting; pump repairs; plumbing; low cost construction; fabrication and repairs of engineering/household goods; conventional and non-conventional energy devices; diesel and petrol engine maintenance and minor repairs; electrical services; motor rewinding; irrigation systems; nursery plants; agricultural consultancy (practices for various crops); pest control services; animal health services; tyre-tube vulcanising; bio-gas maintenance and many others. All these need simple measurements, calculations and recording, conducting surveys and collecting information. All this is done through the scientists coming in contact with the villagers - it is on a person-to-person level. This has had a tremendous effect. Much more than conducting seminars and workshops. Along side of this multi-skilled training, basic education upto +2 has been taken care of. This has helped the women to develop self confidence. The self confidence and self reliance has been developed to such an extent that many of them have set up small scale industries. A woman entrepreneur - had only 8-acres of arid land to fall back upon. She set up powerlooms to supplement her meagre agricultural income. But the electric supply was insufficient and diesel fired generators costed much. However, she had 4 cattle. This helped her to set up a bio-gas plant. She found that a combination of diesel and bio-gas helped her not only lower the cost of running the powerlooms but it also helped her run it for longer periods. The diesel cost was Rs.6/- per unit, whereas the use of bio-gas brought it down to Rs.0.50 per unit. This has provided employment not only to women but to men also.

Setting up small scale industries by women and enhancing employment opportunities has had a tremendous impact on the village population. A remarkable growth in literacy. In 1977 the total per centage of literacy was below 50%. In 1991 it has risen to nearly 90% (graph).

Similarly population growth has come down and it is marked. The number of persons employed, both men and women has gone up (graph), consumption of electricity and the number of persons using it shows a steep rise (graph), showing thereby that their daily drudgery with manual labour is being taken over by machines.

The introduction of bio-technology is viewed with considerable interest, particularly in horticulture and in the growing of trees of economic importance. Culturing of flower shrubs and plants is a lucrative profession, especially in the South India, because flowers are used in worship and on all auspicious occasions. In addition, it is a fashion to adore the hair with floral designs.

Bio-technology plays an important role in the cultivation of fruit bearing trees like the mango tree. A mango tree takes long years to multiply and yield fruits. But if the growing shoots are cultured using bio-technological methods, multiplication and grafting can be effected in a shorter period.

All these leads one to conclude that for the development of an under-developed country, "High-tech" in its simple form is what is required. Technology should be area specific, target specific and time specific. This is the only method which will help women in the 3rd world countries to better their status and self reliance.

This is particularly relevant at the present juncture. The cold war has ended and this has led to the tightening of the reins over the flow of advanced technology. There is also growing evidence that technology-control strategies are changing from an East-West perspective to a North-South perspective. This is clearly evidenced by the USA limiting trade sanctions against the Indian and Russian civilian space agencies to prevent the Cryogenic engine deal.

Thus the "man-dominated" advanced technology of the West wants to regiment and restrict free flow of technical knowledge leading to

'information capitalism'. The several ills that the world is facing today - environmental contamination, world hunger, global warming etc. are brought about by "INSTRUMENTAL THINKING". At this juncture, women scientists and technolgists should step in to **resituate** human values, human relations, concepts of community and social responsibility. That will help bridge the gap between "high-tech" and "lo-tech" and "expert" and "non-expert" sectors and help establish human-centered, diverse, resourceful and durable technolgies.

I would like to end by a verse from T.S. ELIOT who said -

"Where is the life we have lost in living
Where is the wisdom we have lost in knowledge
Where is the knowledge we have lost in information?"

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THE RATIONALE, DEVELOPMENT AND EVALUATION OF A VIDEO TO ENCOURAGE GIRLS TO STUDY COMPUTING

Val Clarke and Joy Teague

Une comparaison entre les résultats d'entrevues effectuées auprès d'étudiantes inscrites à des programmes d'ordinatique de troisième cycle et celles de professionnelles travaillant dans le secteur de l'ordinatique a révélé que les deux groupes avaient des perceptions totalement différentes des emplois des diplômées en ordinatique. Dans une tentative visant à resserrer les écarts entre la réalité des professionnelles et les perceptions fictives des étudiantes, nous avons réalisé une vidéo de 26 minutes dans laquelle une vedette de télévision populaire a posé des questions à six professionnelles sur leur emploi de l'ordinateur dans le cadre de leur emploi, ainsi qu'à un certain nombre d'étudiantes sur ce qu'elles pensent de l'informatique et des carrières en informatique. Des évaluations qualitatives et quantitatives de la bande vidéo ont été effectuées. Les résultats de ces évaluations ont révélé que la bande vidéo avait eu un impact positif sur les attitudes des étudiantes des écoles secondaires qui l'ont visionnée.

THE RATIONALE, DEVELOPMENT AND EVALUATION OF A VIDEO TO ENCOURAGE GIRLS TO STUDY COMPUTING

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ABSTRACT

A comparison of the responses of interviews of students enrolled in tertiary computer science courses with those of professional women working in computer science showed that the two groups had radically different perceptions of the jobs of computer science graduates. In an attempt to bridge the gap between the reality of the professional women and the fictitious perceptions of the students we made a 26-minute video in which a popular television star interviewed six professional women about the ways in which they used computers in their jobs, and a number of secondary students about their views of computing and of careers. Qualitative and quantitative evaluations of the video were conducted. The data from these evaluations were interpreted as showing that the video was having a positive impact on the attitudes of the secondary school girls who viewed it.

RATIONALE

The Problem. Australia has a very gender segregated workforce with the majority of women concentrated in three occupational areas (nursing, teaching and secretarial services), and with few women in the higher paying, higher status positions in business and industry (data from Castles, 1989). Focusing on the computer industry itself, men tend to be employed in the higher paying, higher status jobs of systems analyst and computing management and women in the lower level positions of data entry and operations assistant (Anderson, 1985; Gutek & Bikson, 1985). In 1980 in the United States women represented only 23% of systems analysts and 92% of data entry operators. Although the proportion of women systems analysts increased throughout the 1980s, by 1990 women still represented only 32% (Frenkel, 1990). The problem is not restricted to Australia and the U.S. In The Netherlands, in 1989 only 10% of systems analysts and 15% of programmers were women (Tijdens, 1991). One of the reasons for the apparent limitation on the career prospects of Australian girls is their choice of subjects entering Years 11 and 12, where fewer girls than boys enroll in courses in mathemat-

ics, physics, chemistry and computing which facilitate their entry into many university courses. In the state of Victoria in 1992, 26% of students enrolled in computer science were girls. However, girls were choosing to enrol in courses focusing on packages (56%) and social issues (67%) (Taylor, 1992). The same problem has been highlighted in relation to mathematics where The Australian Association of Mathematics Teachers (1991, p. 58) has noted that: 'Girls in Australian schools, however, participate less in mathematics than boys do: - as soon as it ceases to be compulsory, girls opt to study mathematics to a lesser extent than boys - where there is a choice of levels in mathematics courses, girls more frequently choose the lower levels thus limiting their choices in post secondary courses'. Although female students tend to believe that they lack ability in mathematics, science and computing, recent meta-analyses of the literature relating to gender differences in abilities suggest that (1) the differences are small accounting for less than 1% of the variance, (Linn & Hyde, 1989; Hyde, 1981) (2) the differences are declining, being considerably smaller than they were a decade or two ago (Feingold, 1988), and (3) the differences which do exist occur mainly at the extremes of the ability distribution (Feingold, 1988). As with ability, gender differences in computing achievement are considerably greater in the minds of the students than in their test scores. For example, when all students entering a first year compulsory tertiary computer science and statistics course were asked to predict their grades, the men anticipated considerably higher achievement levels than did the women, but the final results showed that there were no gender differences in performance (Clarke & Chambers, 1989). Similarly, in a meta-analysis of studies of computing achievement, Hattie and Fitzgerald (1987) found few gender differences. It appears that the problem does not lie in gender difference in actual ability or achievement, but in gender differences in expectations about abilities, achievement, courses and careers.

THE REASONS

Reviews of the literature focussing on gender differences in computing participation, attitudes and achievement support the proposition that gender differences in participation are the results of gender differences in beliefs and expectations (Clarke, 1990, 1991). There are several themes which consistently emerge in empirical studies: (1) cultural beliefs that girls are less competent than boys, (2) gender-based differences in expected outcomes of computing experience, often due to the way courses are taught and the nature of the available software, (3)

gender-based differences in the encouragement provided by parents, teachers and peers for computing participation and achievement, (d) lack of female role models in homes, in classrooms and in the media, and (e) the association of computing with mathematics, and to a lesser extent with science and technology. All of these factors lead to gender-based differences in computer access and experience which are in turn reflected in gender-based differences in perceived interest and expectations as to scores on measures of computing ability and achievement.

INTERVIEW STUDY

To further explore these issues we conducted a series of interviews with tertiary computer science students (Teague & Clarke, 1991). Thirty-four third level social psychology students each interviewed a male and a female undergraduate computer science student, asking them why they had enrolled in computer science, what successes and failures they had experienced, why they believed that women were under-represented in computer science courses and what they thought should be done to encourage more women to enroll in these courses. The responses were somewhat disappointing as they reflected the same themes which had emerged from the literature reviews. Overall, female students differed from male students in that (1) they had less previous computing experience, (2) they were less likely to own a computer, (3) they were more likely to have chosen computer science for its good career prospect or because their marks were not good enough for a preferred course and were less likely to have chosen it simply because they liked it, and (4) they were more likely to have experienced problems in gaining access to a computer or in getting a program to run. Female and male students were similar in that (1) they saw successes in terms of getting a program to run, (2) perceived working in computing as requiring little social interaction, and (3) considered that girls were under-represented in computer science due to (i) the stereotyping of careers, (ii) the math/science/technical nature of computing, (iii) girls' lack of encouragement to study computing, and (iv) their lack of interest in computing. As a second part of the study seven professional women working in computing were individually interviewed. The pictures they portrayed of their jobs were radically different from that presented by the students. They talked enthusiastically about the variety in their jobs, the constant challenge of new and exciting projects and the large amounts of time spent working with other people. Most of them spent very

little time working alone at a keyboard and most of that time spent writing reports rather than programming. Their successes were in terms of completing projects and helping others to solve problems. Most of them were unable to identify failures, but believed they had too little time to do all of the exciting things they would like to do. Essentially the professionals saw computing as a people-oriented job while the students perceived it as a technical, programming one. There appeared to be two ways to overcome the students' misperceptions: (1) give them personal experience with the a wide variety of computing activities, and (2) provide them with information about the realities of the jobs, possibly in the form of a video. Elsewhere in this conference we address the first possibility (Teague, Clarke, & Lyne, 1993), while here we will address the second possibility and discuss the development and evaluation of a video.

DEVELOPMENT

Budget. The development of a video required financial support. We applied to the Office of the Status of the Women, Department of the Prime Minister for a grant and received $14,500. Needing additional money we applied to Deakin University for part of the Department of Education Employment and Training Funding for equity and received a further $5,000. For the final development of a cover for the video and the preparation of the accompanying booklet we applied to Deakin University and were granted a further $2,000.

Student Interviews. As a preliminary to making the video we jointly interviewed students from three schools, talking to them separately and in groups to gain ideas as to the attributes which they considered important in a career, what they thought about computing, and the features of a promotional video which they would and would not find attractive. In the case of one group we showed them segments of two videos and assessed their reactions to these presentations. Their generally negative responses indicated the need to make a different type of video especially designed for this audience. Apart from mentioning some popular careers, such as being a vet to work with animals, most of them talked about similar career features. They wanted to work with people, to enjoy their job, to have variety and in some cases a challenge, to make plenty of money, to have flexible hours or the possibility of a career break to have children, and to travel. They certainly did not want to work with computers as that meant being isolated

from people, being stuffy, possibly wearing glasses, and being boring. We decided to use snippets of student interviews between the interviews with the professionals.

Professional Interviews. We selected 12 professional women who were each engaged in different types of activities and spent at least 30 minutes interviewing each one, making a video tape of the interview. Later we studied the videos of the interviews and wrote a profile for each woman. These profiles were originally intended to assist the Director and the Professional Presenter to understand the role of these professionals and for us to identify the points we would like included in the final video. Like the women who had been interviewed in the earlier study, these women all talked enthusiastically about the variety and challenge in their work and the continual need to be working with other people. Again they emphasized the inter-personal rather than the technical nature of their jobs. They were all willing to be included in the filming of a video and were excited about the prospect of doing something to encourage girls to think about studying more computing at secondary and tertiary levels and to enter the kind of jobs which they were finding so rewarding.

Booklet. During detailed discussions with the Director, he convinced us that the attention span of video viewers is limited to 20-25 minutes and we could only have six professional women in the video and about nine or ten of the brief comments from the students. This posed a problem as we felt that all of the professional women had something important to contribute. After considerable difficultly we selected the six women to be included in the video and decided to use all of the twelve profiles in a booklet which would accompany the video. This booklet would provide additional information about the women who were in the video as well as the profiles of the women who could not be included.

ACTION

The Director assembled a professional team of cameraman, lightman, soundman, video editor, coordinator and himself to deal with the technical side of the filming while we provided ideas as to the issues we wished to cover. After spending four days shooting at eight different locations (the work places of the professional women, two schools and the Deakin studio) we spent many hours deciding which pieces of the tape to include in the final product.

THE VIDEO

The video is a 26-minute production in which a popular local television star (Tania Lacy) interviews six professional women about the ways in which they use computers in their jobs. These women are (1) a manager of a department responsible for developing computer-based training packages in a company which employees only women, (2) the video editor at Deakin University who edited this video, (3) a project manager in a large multinational company, (4) a user support consultant in a scientific research organization, (5) a contract consultant analyst who was interviewed in her own home, and (6) a pattern cutter in the fashion industry. To the basic information the professional team added sufficient special effects to make the video attractive to secondary students.

EVALUATION

QUALITATIVE EVALUATION

We undertook an evaluation in two parts. As we were holding a one-week holiday computing program for 20 girls from Year 10 (aged 15 years) we showed them the video. The final question in the evaluation of the holiday program asked them to comment on the video. In their words:

It was good.

It was really good and should be sent to schools around here.

I thought it was really well done.

It was great.

Very good.

Excellent. I recommend to show it to all the girls.

It was good and entertaining.

Good, funny.

It was definitely good. Send it out to other schools, to their career centers.

It was well done having Tania Lacy on it. She's really good, entertaining.

I think the video is great. I liked it.

The video was great. I think you should show it to school kids.

I like the video. It showed me a lot of jobs that computers are used in.
I liked it.
A bit dizzy.
Very good. Should be distributed to all schools and year 10, 11, 12 girls should see it.
Video was good. It needed the humor, otherwise it would have been really boring.
Really good. Informative. Funny. Interesting.
It was good and interesting.

QUANTITATIVE EVALUATION

Design. The second part of the evaluation involved showing the video to intact classes of students in Year 10. We used a between subject group design in which the experimental group was shown the video and then completed a computer attitudes scale, while for the control group the attitudes scale was completed before the video was shown. Unfortunately, this design would underestimate the effect of the video as it gave insufficient time for the students to reflect on the contents before completing the computer attitude scale. Therefore, any significant difference would be indicative of the positive impact of the video.

Sample. The sample was selected from schools from all three sections of the Victorian education system: government schools, catholic schools and independent schools. It also contained both single-sex girls' schools and co-educational schools. In each school two parallel classes at Year 10 were included: one in the experimental group and one in the control group. The sample contained 221 girls, with 119 in the experimental and 102 in the control group.

Instrument. The 45 item Likert-style attitude scale was designed to assess the three components of an attitude: cognitive, affective, and behavioral.

Results. Comparisons of the differences between the mean scores for the two sets of students showed that the viewing of the video had a significant positive effect on the scores on the behavioral component ($t = 1.54$, 216 d.f., n.s.), but not on the cognitive component ($t = 1.54$, 216 d.f., n.s.), or the affective component ($t < 1$, 219 d.f., n.s.). However, it is the behavioral dimension which is the most important for predicting future actions so it was considered that the video had had a positive measurable effect on students' attitudes scores.

Conclusion. Taking the two sets of evaluation data together, it was concluded that the video is having a positive effect on girls' attitudes towards computers and that it has achieved its aim of making them aware of some of the ways in which a training in computer science may be used in the workplace.

AVAILABILITY

The video is suitable for showing on Australian and European (PAL format) and American (NTSC format) video players. It is available from the Computing and Mathematics Department, Deakin University, Geelong, Victoria, Australia, 3217 for the cost of $A25 for mailing within Australia, $A45 for mailing PAL format overseas and $A65 for mailing NTSC format overseas. Visa and Master Cards are accepted. The cost includes the video, the booklet, packing and postage. At this stage over 300 Australian schools have purchased a copy of the video.

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IMPLEMENTING AN ENGINEERING SUMMER CAMP

Peter D. Hiscocks

Les femmes sont fortement sous-représentées dans les écoles de génie canadiennes. Toutefois, on a démontré qu'un effort relativement limité en matière de recrutement pourrait déjà contribuer à des résultats importants. Compte tenu de cela, l'Institut polytechnique Ryerson a créé, pendant l'été 1991, un programme de camp d'été intitulé **Discover Engineering** (Découvrez le génie) à l'intention des adolescentes du palier secondaire. Ce document décrit les leçons tirées de ce projet.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

IMPLEMENTING AN ENGINEERING SUMMER CAMP

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ABSTRACT

Women are significantly under-represented in Canadian engineering schools. However, it has been shown that a relatively modest effort at recruitment can yeild significant results. With this in mind, in the summer of 1991 Ryerson established **Discover Engineering**, an engineering summer camp program for young women in high school. This paper describes lessons learned from the project.

PROJECT DESCRIPTION

A number of strategies have been used to encourage young women to consider engineering as a career, ranging from one page leaflets to multi-week mentoring programs. Ryerson opted for an initiative consisting of a one-week program of engineering related, hands-on activities aimed at female high school students entering grades 11 to 13. Ryerson operates four sessions of this summer camp, each with 20 students.

Interventions are required at all levels of the educational system, and we have focussed our efforts on senior high school students. They are a suitable designated group because:

- the project encourages students who do have the necessary courses to consider engineering
- the age of the participants is similar to that of university undergraduates, so there is a suitable 'fit' with the teaching styles and materials of the university: this would not be true for a younger group.
- it is important to show concrete results fairly soon and these students will make career choices in a year or two reflecting the effectiveness of the project.

The objectives of the camp program are as follows:

- To identify the enormous range of activities and occupations that comprise engineering.
- To instill confidence and create excitement by doing actual engineering 'mini-projects'.
- To show that engineering involves working with people, as well as things.
- To demonstrate that women have successful, enjoyable and productive careers in engineering.
- To encourage women high school students to see themselves as potential engineers and scientists.

In order to provide role models and opportunites for students to meet and interact with women engineers, the camp is assisted by two women engineering students. As well, most instructors are women engineers and one of the events is a panel discussion with three women engineers who are practicing in various areas of the field.

A camp timetable is shown in figure 1. There are 20 students in a camp session, and they are divided into two groups for some activities.

As much as possible, the students do hands-on projects in the engineering labs. The **Ryerson Info-Hunt**, is a scavenger hunt in which students engage in a search for information about a typical university campus. **WAMMO-The Career Game** is a giant board game played by two teams in which issues are raised related to women in the workplace, home, and education.

Student questionaires and anecdotal evidence from the seven sessions of the camp to date indicate that the camp project is effective in encouraging young women to seriously consider an engineering career. In the remainder of this paper I shall detail some of the lessons we learned in the process of putting this project together.

CREATING SUPPORT FOR THE PROJECT

In addition to a steering committee, which provides ideas, contacts and information, it is important that there be a small nucleus of people who are willing to take responsibility for the project and see it through to completion.

This type of project has two main components: engineering and equity. Thus the project manager or management team should include expertise from both areas. A

Monday Morning	Introduction to Engineering
	Tower Building Exercise
	Engineering as a Career
Monday Afternoon	Biomedical Tour (The Hugh MacMillan Rehab Centre)
Tuesday Morning	Group A: Autocad and Machining
	Group B: Holography
Tuesday Afternoon	Group A: Electronic Project
	Group B: Autocad and Machining
Wednesday Morning	Group A: Holography
	Group B: Pneumatic Controls
Wednesday Afternoon	Group A: Pneumatic Controls
	Group B: Electronic Project
Thursday Morning	Environmental Tour and Civil Engineering
Thursday Afternoon	Group A: Wind Tunnel
	Group B: Info Hunt
	Group A: Info Hunt
	Group B: Wind Tunnel
Friday Morning	Analysis of water samples
	Extraction and analysis of fats
	Mass spectrometer analysis of gasoline
Friday Afternoon	Panel Discussion with Women Engineers
	WAMMO, The Career Game
	Wrapup

Figure 1: Discover Engineering Session Timetable

project to improve the representation of women must be driven by a strong commitment from the engineers involved. As well, there are many aspects of the project which relate to equity issues.

The next requirement is an involvement at the management levels of the instititon. It is also essential that there be involvement of senior administrators of the institute, including the Dean of Engineering and the academic vice-president of the institution. Without this support, the project simply will not go ahead.

To obtain this support, it is important to emphasize the benefits of the project. If courses are undersubscribed, the university benefits very directly with an increased number of women engineering students. If courses are fully subscribed, women appli-

cants represent an opportunity to be more selective with entrance requirements.

For an industrial sponsor, the opportunity to support this type of project represents a concrete way to demonstrate responsiveness to an important social issue and will eventually lead to more engineering talent in the workplace.

FUNDING

People who work on the camp project by teaching or operating laboratories have to be paid for their labour. Volunteerism works for a short time but if any significant level of work is required, people burn out and the project collapses. However, salaries for instructors represent a major cost to the project and require that the project be carefully planned and solidly funded.

Student fees are a limited source of income. We have chosen to set the student fee at $50, which covers about one-quarter of the cost of operating the camp. Fees have deliberately been set at a level that should not discourage students from attending. In addition, bursaries are available for students who request them. About 20% of the students apply for bursaries.

Since student fees do not cover operating costs, external funding is required and this presents a 'chicken and egg' problem. The project cannot proceed in any significant way without funding, and complete funding is usually not available from the institution. On the other hand, industry sponsors are understandably reluctant to contribute funds toward a project unless they know it will be managed and funded properly. One solution to this dilemma is to ask the university for a 'funding guarantee'. The university guarantees to cover project losses with the understanding that the project managers will do their best to find alternative external sources of income. In a university setting, the Development Office may be able to help with advice and suggestions of external funding sources.

With a funding guarantee, scrounging for bits and pieces of money from different sources inside the university, industrial sponsorships, volunteer management, and minimizing the project costs, it should be possible to run the first camp session.

LESSONS ON FUNDING

- It should be understood that the phrase *We don't have the necessary funds to do this project* means *Among the competing projects for this funding, you have not established a strong enough case that your project is a priority.*

- You must establish a comprehensive and airtight case for the project. To you and the others in your group it may be perfectly obvious why this project should have priority, but it's not necessarily obvious to outsiders. Advantages of the project to the institution, and the successes of other institutions, must be carefully documented. Networking, tact and persistence are important.

- It is important to present a professional image to industry and government sponsors, which means that all materials going to sponsors must be desktop published, a letterhead must be created, and project publicity materials such as a poster must be of a high standard.

- Be careful to identify the benefits of the project, especially those centred around visibility, to external sponsors.

The first session is the most difficult. Once internal and external sponsors have seen the positive results of the first session, it is much easier to obtain funding support.

DESIGNING THE CURRICULUM

The exact content of the curriculum is not crucial, since the curriculum is primarily a vehicle for the experience of engineering. The curriculum design can be tailored to the people and facilities available. However, engineering students consistently cite meeting a woman engineer as the most important factor in their decision to study engineering, so it is vital that the students meet women engineers in the course of the camp.

The curriculum should be designed around hands-on activities and should discourge lengthy lectures. It should be recognized that it is most important to communicate excitement and interest rather than the precise details of a subject.

Much of engineering is conducted with other members of an 'engineering team', clients and other professionals, and it is important to demonstrate this to the students.

Finally, the entry of women into the engineering profession is part of the process of the redefining the role of women in society, and a discussion of this is important and relevant to the camp curriculum. In Discover Engineering, we use the career game WAMMO (Women Advancing, Men Move Over) to explore these issues.

TEACHING RESOURCES

Summer camp projects for public school students (up to grade 8) usually employ engineering students as instructors. Queens Quest at Queens University (Howard, 1989) and Science Quest at the University of Toronto are two projects of this type.

Discover Engineering, however, is aimed at senior high school students and so requires that the staff be university level professors and lab instructors. It's also possible to hire in engineering consultants and to visit the engineering laboratories of sponsoring companies as part of the curriculum.

PUBLICITY AND RECRUITMENT

There are 140 high schools in the Metro Toronto area, so one would expect that it would be a simple matter to attract students to the camp. However, we have found that it is not sufficient simply to mail out a poster to the high schools. A teacher or counsellor must encourage a student to see herself as an attendee and possibly, eventually, a working engineer.

In the process of recruiting students for the camp, we have learned that:

- It is best to have a specific contact in the high school, someone who will promote the project to students.
- It is adviseable to mail an application package (poster, information, application forms) to the Head of Mathematics, the Head of Science, and the Head of Counselling in each high school. There are many summer activities competing for the attention of high school students, and the summer camp must be prominent.
- The most suitable times for the camp are at the beginning and end of the summer. In mid summer, many students have jobs or are away on summer vacation.
- Most of the students who apply come from a small percentage of the schools. This confirms the view that it is important to have someone in a particular high school who encourages women into non-traditional careers.
- We see a disproportionate number of applications from all-female schools. This suggests, as has been documented elsewhere, that girls are more likely to continue and succeed in mathematics and science in a single-sex environment.

- About two-thirds of the 140 contacted schools have sent one or more students to the camp. The remaining third have yet to do so. This highlights the ongoing problem of communicating about careers in engineering to young women in high school.

Our experience is that about 170 students apply for the 80 positions in the camp. If the facilities existed, the number of applicants could be increased with a more elaborate promotional campaign.

ENSURING PROJECT LONGEVITY

In order to ensure that the project can continue over a period of time, it is important not only that the instructors are paid but that someone has management responsibility for the project as part of their regular job. This, in turn, requires that there be reliable sources of funds for the camp. This arrangement can be self-sustaining, inasmuch as the project manager can be responsible for finding funding support for the project.

ASSESSING PROJECT EFFECTIVENESS

It is important that the success of the camp be highly visible, both within the host organization and to the industrial sponsors. Sponsors like to hear about the successes of the project, and at times other than when they are being asked for money. This, in turn, provides the contact person in industry or government with material to convince their administration of the worthiness of the project.

To this end, we produce an annual report on the camp, with photographs of the camp sessions. We also have the students do a questionnaire at the end of each camp session, and we include the results in the annual report.

In the questionnaire, students have told us that they learned about engineering and discovered that one does not have to be a technical genius to enjoy a productive career in engineering. They were encouraged to pursue a non-traditional career, and especially enjoyed meeting women engineers and other young women with similar interests.

The main point of this project is to encourage more young women into engineering. However, the project has also led to important contacts in the sponsoring industries and government agencies, and has had a positive effect on the public view of the university. Thus, there are spinoff benefits beyond the direct effect of the project itself.

ACKNOWLEDGEMENTS

The Discover Engineering summer camp project was put together with the help of over 40 individuals in Ryerson Polytechnical Institute, the sponsoring industries and government agencies. The cooperation and support of this number of people is an indicator of the positive climate that exists for this type of project, and is greatly appreciated.

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AN INTERVENTION PROJECT AIMED AT GIVING GIRLS A BETTER CHANCE IN SCIENCE

Lore Hoffmann, Wolfgang Bünder, Peter Häussler,
Peter Nentwig, Sabine Peters-Haft

De nombreux résultats d'enquête confirment que l'enseignement de la physique et de la chimie ne tient pas compte des intérêts et compétences des filles. Le projet présenté ici a été développé pour en tenir compte. Il met l'accent sur la première année de l'enseignement des sciences physiques (7e année) et sur la première année d'enseignement de la chimie (9e année), ainsi que sur une série de six phases d'une durée totale de deux ans et demi. Ce projet a été lancé en août 1991. Les éléments importants de ce projet d'intervention sont, entre autres : un mélange d'enseignement mixte et séparé comparé à un enseignement entièrement mixte; sensibiliser les enseignantes et enseignants à leurs propres préconceptions des sexes et à leur comportement; le développement d'une structure de programme pour la physique et la chimie de base qui prenne en compte les contextes environnementaux des filles, leurs intérêts et leurs aptitudes; l'élaboration de stratégies visant à contrôler le comportement des enseignantes et enseignants variant selon le sexe; élaborer un concept de soi élargi pour les filles et pour les garçons, tant dans l'enseignement mixte que dans l'enseignement séparé; l'élaboration de matériel pédagogique suffisant, ainsi que d'outils d'enquête pour évaluer le projet. La première année a été réservée au développement de nouveau matériel pédagogique, ainsi que de stratégies visant à contrôler et à modifier le comportement stéréotypé du personnel enseignant. Depuis août 1992, ce matériel et ces initiatives ont été testés dans différentes écoles. En tout, douze enseignantes et enseignants (6 en physique et 6 en chimie), dans 24 classes de six écoles (des gymnases, comme nous les appelons) ont participé à ce programme d'intervention. Un concept d'évaluation a été conçu pour retracer les effets et comparer les résultats avec 16 classes témoins de différentes écoles.

La conception et les objectifs de ce projet seront présentés. Les variables du projet seront établies et les premiers résultats et impressions seront partagés.

Le document de recherche est disponible auprès des auteurs.

AN INTERVENTION PROJECT AIMED AT GIVING GIRLS A BETTER CHANCE IN SCIENCE

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Numerous investigation results confirm that physics and chemistry science teaching do not take into account the girls' interests and competencies. The project presented here has been developed to take this into account. It is focused on the first year of physics instruction (grade 7) and the first year of chemistry instruction (grade 9) as well as a core of six phases, planned for two and a half years. It started in August 1991. Important components of the intervention project are, among others: a mixture of coeducation and single sex education in comparison to completely coeducational teaching; making teachers aware of their own sex-determined preconceptions and behaviour; the development of a curricular structure for basic physics and chemistry that takes into account girls' own environmental contexts, interests and abilities; the development of strategies to control the teacher's own sex-determined behaviour; to build up an expanded self-concept for girls and boys, both in coeducational and single-sex teaching; the development of sufficient teaching materials as well as of investigative instruments to evaluate the project. The first year has been reserved for developing new curricula and teaching materials as well as strategies to control and change the teachers' own sex-stereotyped behaviour. Beginning in August 1992 these new materials and strategies are being tested in schools. As a whole, 12 teachers (6 physics and 6 chemistry) with 24 classes in 6 high schools (our so-called Gymnasien) are taking part in the intervention program. An evaluation concept has been designed to trace effects and for comparison with 16 control classes in different schools.

The design and the goals of the project will be presented. The variables of the project will be elaborated and first results and impressions will be shared.

THE IT EQUATE ACTION RESEARCH PROJECT IN THE UK

Gillian Lovegrove, Wendy Hall and Mari Booker

Treize à 14 ans : un âge difficile dans la vie des adolescentes et adolescents. Il est de plus en plus clair que bien qu'à l'école primaire les filles et les garçons soient également réceptifs aux leçons de technologie, à l'école secondaire, un changement important se produit, si important que lorsque les étudiantes et étudiants sont prêts à se lancer dans des études supérieures, la proportion des filles intéressées au domaine de la technologie est beaucoup plus faible. Il est également évident que les influences au travail sont nombreuses et variées. Les études en recherchant les causes sont bien documentées, mais les stratégies efficaces pour améliorer la situation sont peu nombreuses.

Ce document décrit la recherche active effectuée dans les écoles du Royaume-Uni, qui met l'accent non seulement sur les méthodes d'enseignement et le contenu des classes en technologie de l'information, mais qui tente également d'améliorer la situation en encourageant les institutrices et les instituteurs, les conseillères en orientation et les conseillers en orientation, les responsables d'école, les parents et les gouverneurs à participer activement.

Le projet pilote a été mis en oeuvre dans le Hampshire et dans les quartiers des docks de Londres, au Royaume-Uni. Des questionnaires ont été distribués à des filles de 13 à 14 ans, ainsi qu'à des institutrices et instituteurs. Ils ont permis de réunir des statistiques utiles et de recueillir d'excellentes suggestions pour les domaines de la recherche active auxquels les écoles individuelles souhaitaient éventuellement participer.

Ce document décrit les réalisations du projet, y compris le choix attentif des écoles, les questionnaires initiaux, les domaines de la recherche active et les questionnaires par chocs. Des suggestions d'améliorations ont été faites pour les stratégies de la recherche active. En mettant en oeuvre ces stratégies dans un plus grand nombre d'écoles, on espère que les personnes qui se trouvent dans l'environnement global d'apprentissage des filles modifieront progressivement leur comportement afin de permettre une prise de conscience du besoin de sensibilité au niveau des sexes dans le domaine de la technologie de l'information et de fournir du matériel scolaire efficace et précis sur les carrières pour les filles.

THE IT EQUATE ACTION RESEARCH PROJECT IN THE UK

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ABSTRACT

The age of 13-14 years is a time of great change in the lives of teenagers. It is becoming clear that whereas at primary school girls and boys are on the whole equally receptive to lessons involving technology, at secondary school a change occurs such that by the time pupils are considering higher education, the proportion of girls interested in technology is significantly lower. It is also clear that the influences at work are many and varied. Research on the causes is well documented but effective strategies to improve the situation are few.

This paper describes action research in schools in the UK which focuses not only on teaching methods and content of classes in information technology, but also attempts to improve the situation by actively involving school teachers, careers teachers, head teachers, parents and governors.

The pilot project has taken place in Hampshire and the London Docklands in the UK. Questionnaires were given to girls aged 13-14 and also teachers at the schools, which gave useful statistics and also suggestions for areas of action research in which the individual schools might wish to participate.

This paper describes the progress of the project including the careful choice of schools, the initial questionnaires, the areas of action research and the impact questionnaires. Suggestions are made for improvements in action research strategies. By implementing these strategies in a greater number of schools, it is hoped that those involved in the whole learning environment of the girls will gradually change their behaviour to develop a greater awareness of the need for sensitivity in the provision of equal opportunities for girls in information technology and in the provision of effective and accurate careers material for girls.

INTRODUCTION

It has been estimated that the content of at least 10 million jobs in the UK today can be classified as handling and processing information. With significant advances in technology and the advent of the paperless office, automated factory and cashless society, this figure can only increase. Many jobs involve the use of information technology in an integral way.

The demand for personnel with specialized skills in this area exceeds supply (though perhaps not at the height of a recession). An Information Technology Skills Agency survey (ITSA, 1989) of over 400 major IT users in the UK showed that the proportion of trainees in post, not only did not exceed the level of normal staff loss, but was well below that figure.

At the same time, the number of school and university leavers entering the workforce is falling as a result of the declining birth rate over the last two decades, with an anticipated shortfall of 1.2 million 16-24 year olds in the UK expected by 1995. Clearly one way of alleviating this problem is to make the best use of all sources of labor.

Another disturbing statistic observed during the last decade (Lovegrove & Hall, 1991) is the dramatic fall in the proportion of girls entering undergraduate courses in universities in the UK in computing-related subjects. Despite efforts by universities through Women into Computing workshops for girls and for women returners, and other projects effected through the Women into Science and Engineering (WISE) and Women into Information Technology (WIT) initiatives (Virgo et al, 1991), this loss in the proportion of girls has not been recovered. This phenomenon appears in Western Europe rather than Eastern Europe (Lovegrove, 1991; Durndell, 1991).

ESTABLISHED AND FUNDED RESEARCH

Many research projects relating to equal opportunity issues in education have been concerned with the attitudes of girls to maths and science. Notable examples are the "Girls into Science and Technology" (GIST) project based at Manchester University and the WISE initiative (Whyte, 1986). The positive outcomes of these projects and other national and local initiatives may be reflected in the general increase in the numbers of women reading maths, science and engineering-related subjects in higher education (Lovegrove & Hall, 1991).

The phenomenon relating to girls' attitudes to Information Technology (IT) is a fairly recent one. In 1983 the London Borough of Croydon produced a report for the Equal Opportunities Commission (EOC) "Information technology for Schools: a guideline for good practice for teachers of IT". The follow-up project (Girls and Information Technology) evaluated the effectiveness of the project in helping teachers to provide equal opportunities for girls and

boys in IT classes. This report stressed the need for computing and IT courses to be made attractive and relevant to girls and made recommendations for how this could be achieved, including an increase in the number of female IT teachers and earlier career education.

In 1987, Judith Ellis published a report following a two-year project which was particularly concerned with the use of the computer in the primary classroom, the reluctance of women teachers to use the computer in their classrooms and the attitudes of the girls towards computers. Three issues of relevance to the successful use of computers in the primary school by all teachers and all children were identified: the organization and management of the computers' use throughout the primary school, the organization and management of the computers' use in the primary classroom, and the choice and use of software.

In a study of adult computer dependency (Shotton 1989), it was found that the ratio of female to male computer studies teachers was 1:3 and that 72% of the children taking General Certificate of Education (GCE) in Computer Studies or Computer Science were boys. 53% of the boys owned computers at home compared with 32% of the girls. Girls rarely made use of computing facilities during computer club sessions at lunchtime and after school. It was found that two groups of girls in particular were said to enjoy computing more than most: those from the single sex school and girls of Asian origin. Culley (Culley, 1986) endorses this with her evidence that in girls-only schools there is no shortage of enthusiasm for computing.

These are just some of the observations made over the last few years, but the problem remains unsolved and unchanging. It may be that making recommendations for change is simply not sufficient, particularly if staff in schools do not believe there is a problem in their own school. This project is an attempt to bring about change through action research.

AIM AND OBJECTIVES OF THE IT EQUATE PROJECT

This research project aims to develop strategies for changing attitudes and eliminating the institutional barriers which deprive girls of the opportunities for involvement in IT at all levels, particularly in the lower secondary school.

The objectives are:

- to determine how the masculine image of IT can be altered;
- to maintain at secondary level the skills and competence which many girls acquire at primary school;
- to determine how advice given through the careers service can be presented so that girls are made more aware of the opportunities for them in IT and the importance of IT to many jobs;
- to establish collaboration and partnerships between employers and teachers which will focus on gender inequality in order to develop strategies for involvement and achievement of girls and IT;
- to change attitudes at senior management and classroom level so that IT is seen as important and relevant to girls as well as boys;
- to design, implement and evaluate in-service courses and workshops for teachers to raise awareness of equal opportunities issues in relation to IT;
- to design curriculum materials which will attract girls as well as boys to consider careers in computer-related areas and demonstrate the relevance of IT to the future lives of all pupils.

The Project Officer and one of the Co-Directors are based at the University of Southampton and the other Co-Director is at Staffordshire University. The overall control and direction of the project is the responsibility of a Steering Group - representatives of the sponsors and LEAs. Another valuable contributor to the project is an educational consultant.

CHOICE OF SCHOOLS

The pilot project took place in co-operation with Hampshire and London Docklands LEAs. With the help of IT advisory staff in the LEAs, initial lists of schools were drawn up to try to include potentially influential factors. One single-sex school in each area was included, a school in the country and one in a town, a richly resourced school, a poorly resourced one, one with a male head of IT, one with a female head of IT, schools with ethnic variations and schools of different sizes. In this pilot project, it was decided that the plan of action should be to make visits and give questionnaires to pupils aged 13-14 (named Year 8 in the UK) and their teachers. Both the teachers' and the girls' questionnaires went through a number of drafts

and consultations with advisory IT teachers and researchers, followed by a trial run at a large comprehensive school in a neighbouring authority to Hampshire.

To obtain the background information and discuss IT provision and policy, an initial visit was made to the school. Normally the initial questionnaires for both the Year 8 girls and their teachers were also delivered at this time.

Once the questionnaires were completed, returned to the project officer and analyzed, a return visit was made to deliver the results and also to discuss both the implications of the results and the areas for action research.

ACTION RESEARCH/AREAS OF INVESTIGATION

The main areas considered for investigation were:

- computer clubs;
- liaison with feeder primary schools;
- teachers of year 8 girls developing their expertise within a curriculum area;
- links with industry;
- teacher placements in IT-related business or industry;
- influencing parental attitudes;
- bringing the issue of equal opportunities to the attention of governors;
- careers - in-depth discussion with careers teachers and updating IT related careers literature / visits from women in IT;
- visits from the WISE bus.

Approximately a year after the girls and teachers completed their initial questionnaires, they were asked to complete an impact questionnaire to ascertain if any changes had taken place.

DATA AND IMPLEMENTATION

By May 1991, a visit had been made to each of the nine short-listed schools in Hampshire; this gave a background to the school, its pupils and ethnic mix, catchment area, staff, the sex of the Head of IT, the policy on IT and equal opportunities, the existence of a computer club and access to computers, and the number and sites of the computers. Seven schools from the

nine were selected to give maximum variety and coverage, including one which was to be the control school. At a later date an independent girls' boarding school in Surrey asked to take an active part in the project.

Girls' Questionnaires

The questionnaires asked for information about the use of computers at home, at school and about how they viewed their future use of computers in their future careers. Concerning home use, questions included whether they had a computer at home, where it was kept, who helped them with it, what did they use it for, did a member of the family use a computer at work, and did they use a computer anywhere else. Concerning use at school, questions included whether they used a computer regularly in their primary school, their use of computers now, whether any teacher has made them interested in computers, their favorite and least favorite subjects, how good they felt about using computers, ideas for improving computing in their school, whether they would like to use a computer more often and information about computer clubs in school. They were asked about the ideas they had about a future career, whether they thought they would use a computer in their job, whether they would like a job in which computers played a large part and whether they saw themselves as working for a computer company in the future.

Teachers' questionnaires

The teachers were asked for their subject area, age-range of pupil, academic qualifications, any staff development courses with an IT element taken, what direct training they had received in IT, how they used computers at school or home, about their knowledge of link primary schools in connection with IT, and about whether they thought the girls in their school had equal opportunities in IT.

Action research

After consultation with the teachers, action research in one or two areas was chosen for each school, so that a broad coverage of areas was achieved overall. Impact questionnaires were given to the girls and the teachers approximately 12 months after the initial questionnaires.

The impact questionnaires asked many of the same questions again but also asked what had changed in the last 12 months.

RESULTS AND CONCLUSIONS

Initial questionnaires were successfully handed out and returned. Returns of impact questionnaires on the other hand have been delayed and received from only a few schools. This is believed to be due to an already extremely busy schedule for the teachers. A full analysis of all the questionnaires should take place during the Spring of 1993.

It would be premature to anticipate the statistical results, but the results from the initial questionnaires would seem only to confirm the experience reported in other research, including for example that a far more positive attitude in girls can be found in single-sex schools than in mixed schools.

By being involved in the action research project at any level - from simply an initial telephone contact through initial visits, consultations, questionnaire delivery and finally the positive action research, the schools can be considered to be affected by the action research in that their level of awareness of the situation was raised. The project team believes strongly that teachers taking part in the action research would change their behaviour and thence in the course of time their attitude towards equal opportunities for girls in IT. It is too early to measure that change. More research is needed over a longer time.

According to Lippitt (Lippitt, 1974) innovation will be advanced if there are good communications between teachers, if the head of the school supports the innovation activity, and if s/he creates a staff atmosphere of sharing and experimentation. This view is endorsed by our findings also.

FUTURE WORK

Obviously until the full results from the statistical analysis of the questionnaires have been obtained, no firm recommendations can be made. However, from the experience gained in visiting the schools, it is likely that schools and thus their pupils would most benefit from discussing and reviewing the following:

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

* the IT policy in the school and the National Curriculum non-statutory guidance on equal opportunities;
* in-service training for all staff and support for staff unsure of IT;
* arrangements for girls and boys entering a computer room and sharing the computers;
* the ways in which hardware is described and the careful use of labelling;
* computer club organization and provision of software and documentation;
* the involvement of parents and governors in equal opportunities policies;
* obtaining up-to-date information on computer-related courses and careers, computer student and/or industry mentors, links with local universities, colleges and industry.

A full report on the pilot project including sets of recommendations for schools, institutions of higher education, careers services, hardware and software manufacturers and employers is expected in the summer of 1993. However, in the belief that the process of this action research can be highly effective, the project is seeking further funding to continue the research both in these schools and more in other areas of the UK.

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THE SCIENCE LEARNING CLIMATE: DANISH FEMALE AND MALE STUDENTS' DESCRIPTIONS

Jeffrey V. Mallow

Une analyse d'étudiantes danoises aux niveau du lycée et université montre que, comme leurs équivalentes américaines, elles ont demontré plus d'anxiété vis à vis les sciences que les étudiants du sexe masculin, d'après un questionnaire. D'autant plus, une comparaison de matières poursuivies aux universités choisies: Roskilde au Denmark et Loyola aux USA montre de frappantes ressemblances dans le domaine de bifurcation selon le genre des étudiants.

Comment les étudiants examinés regardent-ils ces questions? Comme supplément au questionnaire, nous avons également demandé aux lycéens des commentaires écrits explicant pourquoi ils avaient choisi sois les humanités (ligne des langues) sois sciences et maths (ligne de maths) - terme danois. Nous avons également mené une série d'entrevues avec les étudiants au niveau universitaire ayant choisi les sciences. Les questions étaient destinées à soulever les expériences des étudiants liées au genre par dès le début de leurs études jusqu'au premières années universitaires. Nous nous intéressions surtout aux choix éducationnels des étudiants; par exemple, pourquoi la ligne de maths est elle aussi cherchée des deux sexes, mais la ligne langues est en majorité femelle, et pourquoi les étudiantes universitaires en science cherchent-elles à échapper à l'étude de physique beaucoup plus que ne le fassent les étudiants mâles. Ce document présente les résultats des commentaires écrits et entrevues orales.

THE SCIENCE LEARNING CLIMATE: DANISH FEMALE AND MALE STUDENTS' DESCRIPTIONS

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In a study of Danish gymnasium and university students[1], Danish female students, like their American counterparts, expressed more science anxiety than male students, as measured by a science anxiety questionnaire[2]. Furthermore, comparison of chosen fields of study at our sample Danish university (Roskilde U.) and American university (Loyola U.) showed striking similarities in gender bifurcation.

How do the students we tested view these issues? In addition to administering the questionnaire, we elicited from Danish gymnasium students written comments on why they had chosen to study humanities ("language line") or science ("math line"). We also conducted a series of interviews with university students who had elected to study science. Interview questions focussed on gender issues in students' educational experiences from the earliest grades through their first years at university. We were especially interested in students' educational choices; for example, why the math line in gymnasium is evenly populated by both genders, while the language line is overwhelmingly female, and why female university science students still avoid physics in greater proportions than do males. This paper reports results of written comments and oral interviews.

INTRODUCTION

Several decades of international research studies have investigated the complex causes of gender differences in attraction towards, and performance in science[3]. Of considerable interest are the female enrollment patterns in science versus nonscience[4]. In this paper, students at Nørre Gymnasium and Roskilde University Center, two Danish institutions known for progressive educational innovation, are asked to describe their experiences with science, and the choices they have made.

NØRRE GYMNASIUM

Danish gymnasium education is a three-year sequence for students aged 16-19, who select "math line" (math and science concentration) or "language line" (humanities concentration) upon enrollment. The participants in our study were 73 students in 4 groups: math line, year 3 (hereinafter Math 3) and year 2 (Math 2), and language line, year 3 (Lang 3) and year 2 (Lang 2). One class from each was selected. On the days the science anxiety questionnaires were administered, there were 24 female and 21 male math line students present, and 24 female and 4 male language line students. These proportions are characteristic of gender-bifurcated enrollments in the two lines. In addition to completing the questionnaires, students were asked to answer in writing the question, "Why did you select your line of study [math or language]?" Responses ranged from 1 sentence to several paragraphs, with many responses encompassing several categories. Table 1 summarizes the number of responses by line and category.

--Table 1: Student explanations for choice of subject line--

	Math ♀	Math ♂	Lang ♀	Lang ♂
Number of students:	*24*	*21*	*24*	*4*
Interest in subject	14	15	15	2
Useful in daily life	9	4	7	0
Better at this line	12	17	9	0
Avoidance of other line	3	3	12	1
Useful in career	6	6	7	0
Expect higher grades	1	0	1	1
Parental pressure	0	1	0	0
Attraction to other sex	0	0	0	3
Unsure/unhappy with line	1	2	1	1
External constraints	9	2	0	0

Some responses were expected: Interest and perceived ability largely determined choices. These were frequently coupled with usefulness in daily life and/or future career. However, half

of the math line females and over 3/4 of the math line males cited "Better [ability]" as a factor, while only 9 of 24 language line females (and no males) did the same. They were more likely to cite "Avoidance" of the other line, claiming lack of interest rather than ability. Comments centered on aversion to physics or chemistry rather than math. Math line students on the other hand expressed much less dislike of nonscience subjects. In fact, the last row: "External constraints", refers to the comment made by nine female and two male math line students that, although their interests and abilities were equal in both lines, they had selected the math line because it permitted them to take high-level language-line courses, while the reverse was not true. These comments demonstrate a conscious attempt to balance science and nonscience. In fact, seven males and eight females in the math line listed foreign language, social studies, or music as high-level language line choices. Three language line females on the other hand expressed their (unfulfilled) interest in math, while a fourth complained that she was precluded from taking high-level biology. Comments reflected resentment at this lack of symmetry and its perceived subtext: that in spite of the considerable science/math requirement in the language line[s], language students weren't good enough to do "real" science. This perception, coupled with the overwhelmingly female enrollments in the language line, reenforce gender stereotypes. In this regard, the language line females' claims of avoidance due to lack of interest should be examined. Are they hesitating to articulate a perceived lack of ability or appropriateness? And are math line males exaggerating their ability in response to their perceptions of what is appropriate? The gender-bifurcated responses to the science anxiety questionnaire support these conjectures: females expressed more anxiety about their science courses than did their male counterparts (with no

statistically significant difference between math line and language line students).

Traditional gender norms, especially in enrollment patterns, still seem to hold sway in the language line. The comments of 3 of the 4 language line males that they had chosen the line to meet females may well constitute a protestation of heterosexuality. The math line on the other hand reflects the increase in female enrollment characteristic of other places[4,6].

ROSKILDE UNIVERSITY CENTER (RUC)

15 female and 11 male first-year students in one of the Basic Sciences program "Houses"[7] also took part in this study. Upon completion of the questionnaire[1], students were invited to return in smaller groups for 5 subsequent weeks, to discuss their experiences. Discussions lasted 1 1/2 to 2 hrs, with the number of participants ranging from 5 to 10. The following questions were posed:

1. What choices for advanced study will you make, and why?
2. Why do you think gender distinctions exist in subject choices?
3. Are math and physics naturally dry, or can this be changed?
4. How do your nonscience friends view you?
5. How are you affected by others' views of scientists and science students? Is this gender-related?
6. What types of gender interactions have you experienced at RUC? What do you think of single-sex educational groupings?
7. How many of your teachers in science have been male? Female? How has that affected you? Do they teach differently?
8. Do you experience anxiety in any subjects or situations?
9. What causes of anxiety in science can you identify?

Once the questions were posed, students set the pace and

content of the discussion, often moving back and forth among questions over the course of more than one meeting.

Question 1 attempted to ascertain whether the females and males responded differently without being primed. Vedelsby[6] and Beyer[7] have documented gender differences in choice of advanced subjects at RUC, with females opting less often for physics than for math and biology. This differential appears to be decreasing[6,7], but the absolute numbers are too low to predict trends. In the discussion both males and females singled out physics as "cut and dried", "boring", "closed and theoretical", with only one male arguing the opposite. Similar comments, but fewer, were made about math. Females identified "discussion" as the measure of whether a subject was interesting, with one describing math as a "one way dialogue".

Question 2 focussed on gender issues, but was phrased so as to permit students to distance themselves from the situation. The ensuing discussion was brief and abstract. One female reported that in gymnasium they had discussed whether the differences were genetic or societal; that it was generally believed that most math geniuses were men; and that she thought differences were probably societal. A male described a TV show in which a physician had apparently argued that boys could specialize in science because as the weaker sex, their childhoods had been developmentally more difficult than girls' (sic). These observations were met with equanimity by the other students, and no further responses were forthcoming.

Question 3 was designed to follow up the responses to Question 1. What was it about subjects such as math and physics that made students describe them as "cut and dried", "boring", "closed and theoretical"? The issues of gender and student-teacher interactions surfaced. Remarks focussed on the students' gymnasium experiences. Females dominated the discussion both in number and complexity of their responses,

which centered on the relationship of the teacher to the material. In general, females claimed that their dislike of physics was due less to the nature of the subject than to negative experiences with male teachers. While none of the females reported overt gender bias, seven of their comments emphasized that their attitude towards physics was determined by the quality of the teaching they had received, with four of these conjecturing that their teachers would rather have been doing something else. None of the males made this conjecture, and only one of their comments mentioned teaching as a factor. These observations provide an interesting counterweight to the notion that physics is intrinsically aversive for females. The only two observations about the nature of physics, both by females, did not claim it was "naturally dry", but only that, unlike such subjects as history, it lent itself to a fixed syllabus and a hierarchical presentation. The tone of these comments seemed explanatory rather than critical.

Questions 4 and 5 focussed on stereotyping of science students. Both genders agreed that this was common, more negative than positive, and had a gender component. One female argued that while nonscience students were impressed by science students, they were also "prejudiced" about who could do math and physics: only "good boys with glasses"; she related this to "blocking" (physics avoidance) by girls. Vedelsby[4] has shown that such views were held by nonscience and even by science students. The RUC students took pains to claim that they did not do so, and in fact that RUC selected for "less-dry types" by requiring a range of subjects. Both genders resented antiscience jibes, and having to prove that they were well-rounded human beings. One female concluded the discussion by remarking that "RUC teachers are more integrated [as people], but even at RUC this was not 100% [true]". This point was further elaborated upon in Question 6. Of the three RUC

venues: "house" interactions, project groups, and classes, the first two were less likely to reenforce gender stereotypes than the third, according to one male and one female. Both genders opposed single-sex groupings (mirroring responses of younger students'). These were the only areas of agreement. Females reported that in gymnasium and university classes, males shouted out, answered more quickly, and were reenforced by their teachers to do both. Males disagreed, one arguing that both genders were equally impulsive, and another denying that the problem existed at RUC. Shyness, modesty, and insecurity were singled out by both genders as causes of females' lower level of science participation and even as a filter for entry into university. The most elaborate opposition to single-sex groupings came from one female and one male--both of whom claimed that the two genders think and work differently, and that this improved the educational experience.

Question 7 found, unremarkably, that most of the students' teachers were male. Only one of the 10 students at this discussion had had a female physics teacher in gymnasium. More remarkably, almost every comment made by females in this discussion alluded to female role modelling: four explicitly arguing that it was necessary, two focussing on the "femininity", or lack thereof, of their science teachers, and only two arguing that role modelling, while necessary, was not related to gender. Males focussed more on the teacher's personality, with only one male commenting that he related better to a male teacher, and another stating his preference for female teachers because they were more "authoritative". Responses to Question 6 regarding gender bias in teachers' behavior were complemented here by two comments alluding to students' behavior. One female claimed that males were ruder to female science teachers, while one male claimed that males were ruder to male teachers, but teased female teachers.

Questions 8 and 9 dealt specifically with science anxiety. Female and male students cited the same examples (e.g., asking questions in class, blanking out on an exam, time pressure, homework performance) as do their counterparts in the U. S.[4] Four comments, all by females, differentiated biology from physics (or in one case math): Biology was "holistic"; "written in real language, concrete"; one could have "a relationship, express feelings, have opinions"; "take a position". Of note here is not simply a sampling of attitudes documented elsewhere[4,7,10], but rather the group's apparent maintenance of two contradictory opinions about the intrinsic nature of various subjects: the one articulated here, and the other articulated in Question 3. The difference in the framing of the questions: "Is physics dry?' versus "What makes physics scary?" may probe female students' perception of what should be (physics could be interesting, holistic, etc. if taught well) versus what is (physics as taught now is not). One would surely wish to examine this more closely in light of enrollment patterns in biology versus physics.

CONCLUSIONS

Questions posed here have attempted to elicit the reasons for students' educational choices vis a vis their science experiences. It appears that female selection of science study, while rapidly increasing, still occurs in the face of formidable obstacles, driven by a variety of well-known causes[3,4,9,10]. The fact that students at Nørre Gymnasium and RUC, both noted for consistent attempts to ensure gender equity, articulate feelings similar to those of their contemporaries elsewhere, attests to the inertia of science stereotypes and gender expectations.

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PREPARING BOYS FOR GENDER EQUITY IN SCIENCE

Robina Otrupcek

Les femmes dans les professions scientifiques ne grimpent pas les échelons de leur carrière aussi rapidement que leurs homologues masculins. Une des raisons de cet écart est qu'au sein de l'unité familiale, les femmes continuent d'assumer la plus grande partie de la responsabilité d'élever les enfants et des tâches ménagères.

Pour augmenter les débouchés des femmes, dans les sciences comme dans les autres domaines, nous devons faire comprendre aux hommes que les responsabilités domestiques doivent être partagées et que tant les femmes que les hommes peuvent avoir une carrière et des enfants.

Ce document fournit des façons de présenter ces idées aux garçons, à l'âge où ils développent leurs opinions du rôle des sexes.

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PREPARING BOYS FOR GENDER EQUITY IN SCIENCE

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Abstract

Women in scientific careers are not advancing to higher positions at the same rate as their male colleagues. One reason is because, within the family, they continue to bear most of the responsibilities for child-rearing and household duties. To enhance women's career prospects, in science and in other fields, we need to change men's beliefs about how domestic responsibilities should be divided, and the ways in which both men and women can develop a career while caring for children. This paper suggests ways of presenting these ideas to boys, during the years when they develop their attitudes towards sex-roles.

Introduction

Since its inception in 1985, the CSIRO Women-in-Science (W-I-S) project, has gone a long way in encouraging girls to consider careers in science. Thousands of students have now been visited by women scientists and technicians, and there have been positive responses from some of the schools which reported that, as a consequence, the number of girls choosing to study mathematics and science in secondary school had increased. We now need to expand the W-I-S project to address the problems of inequity for women scientist's in the areas of career advancement, salary structure and career/family load imbalance. To do this we need to change the attitudes in both men and women by altering the extended stereotyped picture of the scientist spending 24 hours a day in the laboratories without any involvement in family or the 'outside world'. This needs to be done at a fundamental level and at an early stage of the children's education.

The Current Situation

Women employed in science careers are not advancing to higher status jobs at the same rate as men (CSIRO 1992, Cribb 1992), despite the fact that 50% of the science faculty enrollments at Australian Universities are now women [averaged across all fields of science available for study (University of Sydney Statistics 1991)]. Additionally their salaries are not as high as male scientists (Holden 1991).

Within the CSIRO however, 35% of the technical staff are female, but women account for only 15% of the professional staff (CSIRO personnel statistics report, 1992). A university study reports that 51% of the tutoring staff are female but only 7% of the professors (Cribb, 1992). Holden (1991) wrote : "The experience gap - No matter how long the women are in science, the disparity between their pay levels and those of their male counterparts persists". As Fig. 1 shows, women's salaries are about 75% of men's for the same number of years of professional experience.

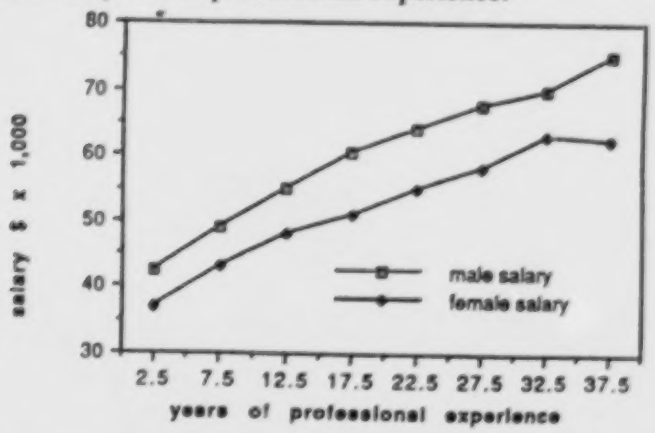

Figure 1. US Women and men scientists' salaries against years of professional experience (from Holden 1991)

The National Science Foundation figures quoted by Holden (1991) also show from the median annual salaries of all employed PhD graduates employed in science, that female salaries are well behind the male salaries for a range of scientific disciplines (Fig.2), with medical science having the greatest disparity and atmospheric science having the least.

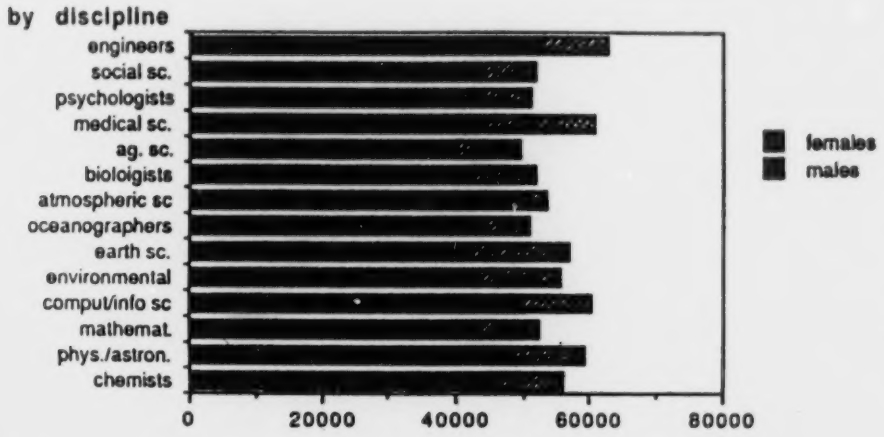

Figure 2. Median annual salaries of employed PhD graduates in 1989 (from Holden 1991).

Women in the fields of science and technology are also more prone to 'burnout' than their male colleagues (Etzion 1989; Grinker *et al.* 1989). Burnout is marked by emotional and mental exhaustion, low work satisfaction, less enjoyment and perceived success and, in general, feelings of disillusionment. It is directly related to stresses such as 'double-burden' or 'career-family' conflict (Grinker *et al.*). Nevertheless, Rosen & Etzion (1989) found that there was no difference between men and women in levels of perfectionism or achievement orientation. It is clear, therefore, that it is not the approach to the job that wears these women out, but a number of factors, one of which is their combined responsibilities at work and at home, and another is their inadequate advancement through the ranks.

What needs to be changed in the current situation

Why and how is the greater burden left to the women? Why do many men feel uncomfortable taking part in child-care and household activities? What stereotyping misconceptions are not addressed in the existing education system and how can these be corrected?

If we are to achieve gender equity in the workforce, then society needs to change so that family responsibilities and career pursuits are balanced between men and women. Gary Knobel from the Human Resources Centre of CSIRO says that: "CSIRO still needs to change its work culture to accept that women and men with family responsibilities can legitimately put their career on hold, while either still working or away from work during key phases of their children's development" (Knobel 1992).

When examining the choice of gender-type activity, and the gender-type behaviour regardless of the choice of activity, we must address the stereotyping of gender roles among young children (Ladich 1991). The CSIRO has already attacked the misconception of the stereotypical scientist with it's W-I-S project (Kingsland 1992). We need now also to dispel the stereotypical picture of the scientist who spends 24 hours a day at the laboratory bench, with no idea of the 'real' world, and no involvement in family activities or child-care.

Brown (1991) extended the W-I-S approach by scheduling women scientists to talk at evening sessions organised for school-age girls with their families present. In a private communication she noted that the presence of their brothers, sisters and parents at the talks seem to result in a more prolonged effect on the interest in non-traditional careers for girls. I believe that this is due to the continued encouragement from the family members, and that a broader audience is being encouraged to adapt to the girls' interests instead of the original approach of training girls to adapt to a male-designed career structure.

How can we do this ?

To produce a general attitudinal change, we need to re-educate both boys and girls about stereotypical activities in the home and work-place. We should approach children in the years that sex-role attitudes are being developed and before their actions are strongly influenced by peer pressure (Ladich 1991).

There have been suggestions that Australian schools follow the lead taken by equity groups in other countries and segregate boys from girls for some lessons. Kruse (1992) intended this method to give the girls a chance to become more self confident and adapt to a male focussed education system, but discovered in the process that an opportunity was created to change the boys awareness of values and attitudes, and adapt to a teaching atmosphere that girls find more comfortable. Sex stereotyping was the concern addressed by single sex groupings in a London equal opportunity project with similar results (Reay 1990).

Certainly in Australia we need to look at stereotyping in schools. The primary school curriculum should include modern parenting classes for boys and girls which shows children there are equitable arrangements in the sharing of household responsibilities. There will be a clear need here to present equity issues to both sexes in simple ways.

Role-modelling is important in influencing stereotyping problems. Male role-models talking to the children in school visits would be useful in this context to discuss not only their own but their wives' careers, and how they share the burden of child-caring and domestic duties equitably. We all know a few shining examples of such role models.

The role-modelling concept could also be used where women have non-traditional careers in science and technology. They can talk about exciting fields of science and how they manage a career and still are effective child-carers.

Interaction with primary age children lends itself more readily to the inclusion of anecdotal information. Details about the ups and downs of their work can include family management and a description of the scientists' involvement in the real world of "eating and sleeping". The way the boys might put this knowledge to use can affect their own sharing of child-care duties in later life, or at least give them an understanding of the problems facing their working wives or their married work colleagues. It is these boys that are going to be the colleagues or partners of women scientists in years to come.

Conclusion

It is clear that a higher proportion of girls are now entering tertiary institutions with the intention of becoming scientists and engineers. This will be reflected in 3 - 4 years time when these women apply to enter the scientific workforce. Pressure for equity of employment and better employer responsibility towards women is here to stay. The process must simply be speeded up now.

Many people have initiated projects to balance the inequities outlined here, and many more are investigating project designs suitable for their own particular version of this same problem.

Indeed at the time of writing, a framework has just been developed by the Australian Education Council (AEC) to advise on strategies for boys "as it relates to the National Policy for the Education for Girls." The AEC commissioned the National Advisory Committee for the Education for Girls to provide a structure within which strategies (based on the experience of girls in schools) may be implemented. Two of the four objectives under the National Policy are specifically relevant to these strategies :

- Equal access to and participation in, appropriate curricula
- Supportive school environments

Behaviours exhibited by boys which inhibit girls from participating and

succeeding in education is identified for action in connection with the National Gender and Violence Project.

Very little adaptation of the Women-In-Science project will be needed to extend it in the direction discussed above. Many of our women scientists who were initially involved in these talks to high-school girls have joined a pool of skilled speakers who have been invited to address a the wider range of audiences, including primary school children. For the W-I-S project to have continued support we need to alert CSIRO to the value of approaching these new audiences.

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ELEMENTARY SCHOOL GIRLS CONFRONT AN ANDROCENTRIC SCIENCE

Carla Pieterson and Arthur N. Geddis

La faible participation des femmes dans les programmes de sciences secondaires et de troisième niveau est souvent attribuée à une socialisation restrictive. Toutefois, le problème peut également être attribué à la nature des programmes de sciences offerts dans les écoles. Les critiques féministes des programmes de sciences suggèrent que la science est une institution culturelle, comportant théories, valeurs et pratiques qui renforcent un point de vue masculin du monde. Ce document explore la façon dont les jeunes filles réagissent aux sciences enseignées dans les salles de classe. Leur comportement, tel qu'il se reflète dans les tâches en classe, est analysé en tant que réactions à une activité principalement androcentrique qui sous-évalue et réduit au silence le sexe féminin. Ces stratégies d'adaptation des filles suggèrent des approches visant à donner aux sciences plus d'importance dans l'esprit des groupes traditionnellement sous-représentés dans ce domaine.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

ELEMENTARY SCHOOL GIRLS CONFRONT AN ANDROCENTRIC SCIENCE

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ABSTRACT

Low female participation in secondary and tertiary science education is often attributed to restrictive socialization. The problem, however, may also be rooted in the nature of the science provided in schools. The feminist critique of science suggests that science is a cultural institution with theories, values, and practises that reinforce a male perspective on the world. This paper explores how young girls respond to the science they experience in their classrooms. Their behaviour as revealed on class assignments is analyzed as responses to a predominantly androcentric activity which undervalues and silences their gender. These girls' coping strategies suggest approaches to making science more meaningful for groups traditionally underrepresented in science.

INTRODUCTION

The low degree of female participation in secondary and tertiary science education is often attributed to restrictive socialization. The solutions suggested tend to be compensatory--skill remediation, increased participation in science activities at an earlier age, exposure to female role models. While these are all useful approaches to the problem, this paper takes a different tact. Instead of looking at the inadequacies of young women, it looks at the science being presented to them and finds in this "school science" characteristics that tend to exclude young women.

Over the last decade a number of feminist scholars (e.g., Carter, 1989; Harding, 1986, 1989; Keller, 1985; Rossiter, 1982) have participated in a broad critique of the dominant view of science as culturally-independent, value-free, and gender-neutral.

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Les soumissions - Colloque international GASAT 7, Canada, 1993

Their analysis has revealed the manner in which the accepted theories, practices, and values of science reflect a male perspective. Androcentric science is a "tough, vigorous, rational, impersonal, masculine, competitive and unemotional" endeavour (Rossiter, 1982, p. xv). More than this, it presents its knowledge as the most reliable and certain knowledge available--knowledge immune from the scrutiny of any but it's own practitioners.

Schools explicitly and implicitly perpetuate this stereotype. Classroom instruction provides access to scientific knowledge, and also socializes students into this androcentric world view in a manner that makes it difficult to question either the validity of its perspective or the legitimacy of its authority.

> Beliefs about students (low attention spans, deprived backgrounds), teachers (hard, elitist) and about science (science as objective truth, science as authoritarian, scientists as a super-intelligent elite) intertwine with teacher goals for the classroom (producing good students who obey rules and accept authority), and student goals (getting by, pleasing the teacher) to define a system in which science instruction becomes an almost ideal setting for socialization of students either into conformity or away from access to knowledge. For many of our students, particularly minorities and women, this socialization leads to rejection of science. (Carter, 1989, p. 48)

Girls in elementary school cannot opt out of science even when they find it foreign and uncomfortable. A more extensive study (Pieterson, 1993) based on interviews with a wide range of elementary students has revealed that many students, particularly girls, feel dissatisfied and uncomfortable with school science. There is every reason to believe that an important factor contributing to the alienation of young women is the highly androcentric nature of much school science. If we take this

perspective girls reactions to classroom science instruction can be seen, not as deficit behaviours, but as strategies for coping with alien subject matter. The examination of students' classroom work which follows reveals a variety of such strategies.

SCIENCE AND PEOPLE

The dominant mode of communication in science is one that removes any traces of people and the human struggle involved in inquiry (see e.g., Medawar, 1986). Many young boys appear to have little trouble adopting this mode of discourse. Jeff's description of how he employed a single wire and a battery to light a light bulb already displays many of the features of standard scientific style. (See figure 1.) Laura's diagram contrasts starkly with Jeff's although they had both been engaged in the same activity. (See figure 2.) The most prominent feature of Laura's diagram--the person performing the experiment--is totally absent from Jeff's.

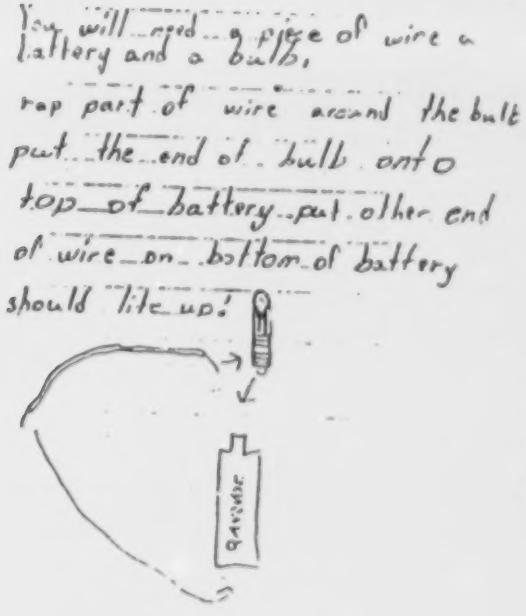
You will need a piece of wire a battery and a bulb,
rap part of wire around the bulb put the end of bulb onto top of battery put other end of wire on bottom of battery should lite up!
Battery

figure 1

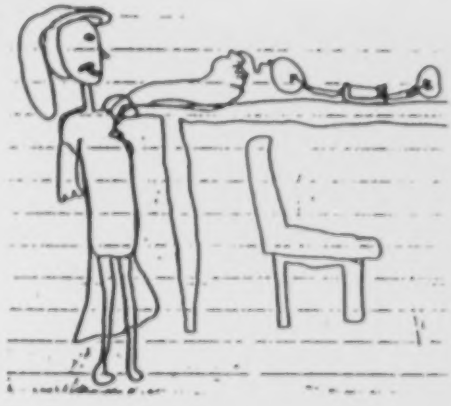

figure 2

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Jennifer's entry in her science activity journal displays a similar awareness of people in her science learning. (See figure 3.)

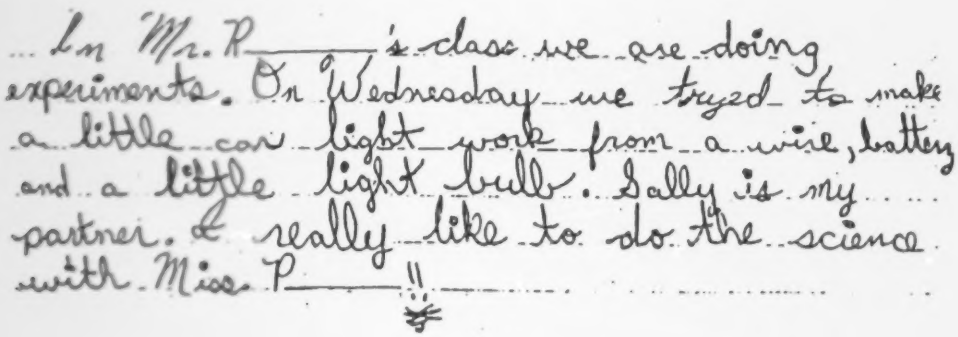
... In Mr. R____'s class we are doing
experiments. On Wednesday we tryed to make
a little car light work from a wire, battery
and a little light bulb. Sally is my
partner. I really like to do the science
with Miss P____!!

figure 3

One of the myths perpetuated by school science is that "the scientist is objective--separate from and unaffected by the phenomena observed." This myth helps support the notion that scientific knowledge is unaffected by individual bias and provides objective truths about the world. According to this view, the scientist is a passive observer--a "victim of the truth" (Longino, 1989, p. 51)--neither responsible for the results nor their application. The classroom work of the two young women presented here suggests that they are attempting to put people back into their science. People are an important part of the scientific enterprise.

SCIENCE AND RELATIONSHIPS

The cultural stereotype of science is not just of an activity devoid of people, but more severely of an activity from which human emotion and feelings have been totally banished. For many young women this is so foreign that they are forced to resist. Their relationships with classmates and teachers are central to the manner in which they come to grips with experience. They tend to be what Belenky et al. (1986) have called "connected knowers".

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Jessica's account of a paper airplane design activity includes her emotions, feelings, and opinions. (See figure 4.) It is very clear that she values her relationships with both Miss P_____ and Melissa, and that she sees these relationships as central to the activity. Jessica appears to be a "connected knower".

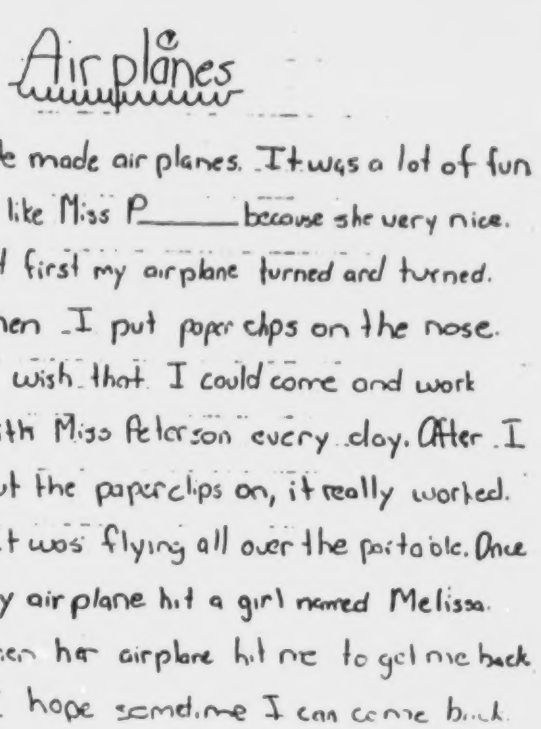
Airplanes
We made air planes. It was a lot of fun
I like Miss P_____ because she very nice.
At first my airplane turned and turned.
Then I put paper clips on the nose.
I wish that I could come and work
with Miss Peterson every day. After I
put the paperclips on, it really worked.
It was flying all over the portable. Once
my airplane hit a girl named Melissa.
Then her airplane hit me to get me back
I hope sometime I can come back

figure 4

Tony's account of the same activity contains no reference to emotions, feelings, or relationships. (See figure 5.) His account is recognizably more "scientific".

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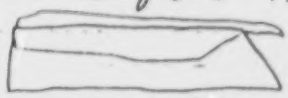
AIRPLANES

We made an airplane it looked like this



then we made some changes I cut two slits in the back to help it lift i soon found out i needed more weight on the front and sides so i put two slits in the sides

figure 5

The establishment and development of relationships is an integral part of the learning process for many girls. "Connected knowers begin with an interest in other peoples's lives, but they gradually shift to other people's way of thinking. . . . Connected knowers learn through empathy" (Blenky et al., 1986, p. 115). Sometimes girls' attempts at relationship building consist of decoration--the ever popular hearts--or short comments added to their work. Often as teachers we dismiss these little extras as doodling or lack of interest, instead of recognizing them as efforts to build relationships. We exhort students to observe what is relevant, write clearly and concisely, and stick to the science. Our lessons are models of the unemotional, mechanistic, objective enterprise that we have been taught science is. It is little wonder that "connected knowers" who value and learn through relationships find

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themselves excluded from science.

SCIENCE AND CONTEXT

In spite of efforts to introduce Science-Technology-Society concerns into the curriculum, science is typically presented as separate from society and its concerns. "Science and society are analytically separate, we are told" (Harding, 1986, p. 39). The pursuit of scientific knowledge is a higher calling, far removed from the lobbying and special interest pressuring that produces the so called "solutions" (read, political compromises) to burning societal issues. While it is increasingly obvious just how inappropriate this stance is, school instruction continues to perpetuate this myth. It would appear that this decontextualizing of science may also be a serious deterrent to the participation of some young girls.

Jenny and Sally are two grade four girls described by their teacher as "weak" science students. They, and their classmates, were engaged in a final project--to make a model, game, or gadget using what they had learned about electrical circuits. The two girls build a rather elaborate gingerbread house out of a cardboard box with lights in the windows that they could turn on and off. They went to great lengths to paint and decorate their house with Christmas tree decorations brought from home.

Sheri and Jennifer's project was presented as a skit. They painted the interior of a large cardboard box blue to represent an underwater scene, and added a variety of plasticine and paper sea creatures. They used their knowledge of electrical circuits to produce two novel characters for their play--a margarine tub and tissue paper jelly fish and an egg carton submarine each connected to a hand held generator.

Jennifer began their presentation.

Jennifer: Has anyone seen a sign near the shore when they were boating?

David: Don't go too close to the shore . . . beware of the jellyfish.

Jennifer: [Holding up a sign] This is a different sign, if you are boating . . . it

says to watch out for manatee. They're an endangered species and you have to slow the motorboats that [might] run over their backs. . . .

Okay. You can tell that our project is "Underwater."

The two girls then proceeded to act out a dialogue between the two occupants of the submarine as they steered their craft--head light on--through the underwater scene towards the beautifully glowing jellyfish.

In each of these projects, the girls put a great deal of effort into providing a context--decorating and adding details--that went far beyond the simple connecting up of electrical circuits. Another teacher casually observing the class working on their projects, commented that some of the projects, Jenny's and Sally's in particular, "seemed more art than science." On the surface, this comment appears valid. We do not expect science projects to include details like paint, candy canes, artificial snow, and wallpaper. The addition of decorations and "frills" left the project suspect in terms of the quality and depth of the science involved. Yet a close examination of the girl's work revealed that their projects contained as many and as sophisticated circuits as the more standard projects devoid of decoration or a story setting. The girls had demonstrated a sophisticated understanding of electrical circuits, but they had gone beyond this to situate this understanding in a context that was meaningful to them .

IMPLICATIONS

Many girls are alienated from science at a very young age. One contributing factor is the kind of science presented to them in the classroom. The classical androcentric view of science as impersonal, unemotional, and divorced from context is uncomfortable and alien for many individuals. The girl's science work highlighted in this paper suggests the need to for teachers and curriculum developers to reexamine the many dichotomies--observer/phenomena, emotion/logic, science/society--that have heretofore characterized science in our schools.

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GIRLS AND SCIENCE AND TECHNOLOGY IN INDIAN SCHOOLS

D' Chandralekha Raghuwanshi

Une «fille» est moins qu'un enfant dans la société indienne. Dans une culture qui idolâtre ses fils et haït ses filles, la femme est presque considérée comme une sous-classe humaine. On réalise aujourd'hui qu'il est impossible de maintenir le rythme du développement en négligeant les quelque 130 millions de jeunes filles âgées de moins de vingt ans. Nous devons les intégrer au processus de développement et de construction de la nation.

La prise de conscience de l'enseignement des sciences et de la technologie pour les filles est de plus en plus importante en partie grâce aux efforts des organismes gouvernementaux et aux programmes de NGO. Aujourd'hui, toutes les filles inscrites étudient les sciences et les mathématiques jusqu'à l'école secondaire (c.-à-d., de la 1ère à la 10^{e} année).

Pour ce qui est des cours de technologie, les filles ont le choix entre plusieurs cours après la 10^{e} année. Ces cours de formation professionnelle sont habituellement la norme dans les classes de 11^{e} et 12^{e} années. Dans ce document, l'auteure décrit les divers cours de sciences et de technologie au niveau de l'école et les différents efforts qui sont déployés en vue d'attirer les filles

GIRLS AND SCIENCE AND TECHNOLOGY IN INDIAN SCHOOL

Dr. Chandralekha Raghuwanshi, President, Science Technology and Environment Forum, Bhopal, India.

A 'Girl' has been a lesser child in Indian society. In a culture that idolizes sons and dreads the birth of a daughter, to be born female comes perilously close to being born as less than human. Now it is being realized that it is impossible to keep the pace of development if we neglect some 130 million girls who are below the age of twenty. We have to bring them to the main channel of development and nation building.

Awareness about Science and Technology education for girls is developing fast partly through the efforts of governmental agencies and partly through the programmes of NGOs. Now all girls who are enrolled study science and mathematics up to secondary schools (i.e. from class 1 to 10).

As far as technology courses are concerned, there are various courses which can be selected by the girls at + 2 level i.e. after 10th standard. These vocational courses are studied at 11th and 12th standards in the schools. In the present paper the author describes the various courses of Science and Technology at the School level in the country and the various efforts to attract girls to these courses.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

A LARGE AMERICAN PROJECT THAT GOT THOUSANDS OF GIRLS INTO MATHEMATICS, SCIENCE AND TECHNOLOGY

Jo Sanders

Trop souvent de nos jours, nous savons comment accroître la participation des filles et des femmes dans les secteurs des sciences, des mathématiques et de la technologie, mais ne parvenons toutefois pas à obtenir du personnel enseignant qu'il agisse en conséquence.

Ce document présente le Computer Equity Expert Project (1990-1993), dans le cadre duquel 200 éducatrices et éducateurs de 12e année, pour la plupart non féministes, sélectionnés dans les 50 États, ont réalisé des développements majeurs. Je décris ici la façon dont ce projet a été élaboré et les facteurs qui, à mon avis, ont contribué à son succès.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

A LARGE AMERICAN PROJECT THAT GOT THOUSANDS OF GIRLS INTO MATHEMATICS, SCIENCE AND TECHNOLOGY

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ABSTRACT

By 1993, it is too often the case that we know what to do to increase girls' and women's participation in mathematics, science and technology, but we cannot manage to get educators to do it.

This paper presents the Computer Equity Expert Project (1990-93), in which 200 mostly non-feminist K-12 educators from all of the 50 states, male and female, accomplished spectacular advances. I describe how the project was organized and the factors which, in my opinion, account for its success.

Now that so many of us have worked on gender equity in mathematics, science and technology in education for so long, I believe we now know what works. What's more, successful strategies don't require schools to expend enormous amounts of time, effort, or money.

What's hard is simply to get what works actually done in the schools. This is because so few educators are feminists or even quasi-feminists, and others don't much care. Many don't even notice that there are few girls in advanced or elective courses, in after-school clubs or inter-school contests, or just in the computer room to play games or do their homework.

I developed and directed the Computer Equity Expert Project from 1990 to 1993, funded for $1.1 million by the National Science Foundation, IBM, Hewlett Packard, Intel, Xerox, American Express, Chevron and Westinghouse. Based on this experience, I think we now know not only what works, but how to get schools to do it. In our national project that

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

operated in all 50 states, here are just a few of the results in participating schools:

NEW YORK - The ratio of girls to boys in the computer lab after school used to be two to twenty-five. Now it is one to one.

WYOMING - Girls' enrollment in Physics rose from 46% to 62%, and in Introduction to Calculus from 45% to 71%.

OKLAHOMA - In 1991, the elective computer science class had no girls. In 1992, it was 31% female.

NEBRASKA - Pre-calculus enrollment, which had been 20% female, is now 45% female.

WEST VIRGINIA - The computer club used to be 5% girls. Now it's 53% girls.

MAINE - For the first time in 12 years, girls signed up for Physics.

MONTANA - Programming class was 0% girls in 1990. In 1991 it was 14%. In 1992 it was 31%.

MASSACHUSETTS - Science Club is now 80% female for the first time ever. Female enrollment in the upper level math course has increased 20%. The math team is now 50% female from less than 20%.

COLORADO - 1991: 15% girls in Computer Programming. In 1992, 30%.

ARIZONA - Enrollment in upper-level math and science courses is up from 18% in 1991 to 30% in 1992.

VIRGINIA - The Advance Placement Pascal class went from 0% to 50% girls in a year.

MISSISSIPPI - In 1991 the high school's academic team in math and science competitions was composed of 7 boys and 2 girls. This year, it is composed of 7 girls and 2 boys.

DISTRICT OF COLUMBIA - Girls' free-time use of computers doubled during the project.

OREGON - Girls' enrollment in Advanced Math rose from 37% to 64% over the last year. For Advanced Chemistry it was 20% to 63%.

77,000 GIRLS AND 9,400 TEACHERS WERE REACHED BY THE PROJECT.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Moreover, these and many other wonderful outcomes were achieved not by committed feminist educators but rather by 200 mostly ordinary teachers and administrators. This is what we did.

THE COMPUTER EQUITY EXPERT PROJECT

We advertised nationally -- free announcements in professional publications, letters to state department of education officials, and direct mail to school district superintendents -- the availability of 200 computer equity "grants": expense-paid trips to a week-long seminar and a three-day followup meeting, $100 for the educator/trainer, and $150 for the trainer's school. Selection criteria were commonsensical: computer experience, training experience with adults, and a demonstrable gender gap in the school in computing, math and/or science.

We received proposals from over 400 applicants and selected the 200 best. They were four-fifths women and one-fifth men, half rural and half urban and suburban, and represented the full range of K-12 schools -- public and private, regular and special. Nearly all the trainers worked in the schools proposed for participation in the project. Few had prior gender equity experience. Many had no prior gender equity *awareness*.

We held four seminars for 50 trainers each. The northwest and southwest trainers met at the California State Polytechnic Institute at Pomona, while the northeast and southeast trainers met at Massachusetts Institute of Technology (MIT). We all stayed in dormitory rooms and met in classrooms.

The week-long seminar included five half- to full-day background sessions: girls' and women's achievement and participation in math and science, teaching math and science using feminist pedagogy, creating sex-fair and race-fair lessons with computers, training skills and tips for equity trainers, and issues in gender equity in education beyond math, science and technology. These sessions were taught by five of the most prominent experts

in these areas in the country: Pat Campbell, Judith Jacobs, Carol Edwards, Dee Grayson, and myself respectively. We also taught two 2.5-hour workshops I had written and published that trainers were to teach to their faculties: *What is Computer Equity?* and *Computer Equity in Math and Science.*

The trainers returned to their schools and taught their workshops to their colleagues. Two-thirds of them then convened computer equity teams as we had strongly suggested, consisting of faculty, often administrators, and sometimes students, parents, school board members and others. These teams decided on strategies they wanted to carry out to increase girls' participation in math, science and/or computers, depending on the team's focus and preferences. Many of the rest of the trainers carried out strategies on their own.

What kinds of strategies did they carry out? • Give girls and their parents instruction in using a telescope and lend it out for weekend Star Parties. • Invite community women working in math, science or technology jobs to school to talk to girls. • Start a Girls' Computer Club. • Recognize and praise girls' achievements and potential in math, science or technology; suggest careers in these fields to them. • Take a group of girls to a local college where math, science and/or technology students and/or professors talk to them. • Contact other teachers to make sure they encourage girls' interests in math, science and technology. • Have girls be the aides in the computer or chemistry lab. • Stop saying "guys" to refer to female students. • Control the tendency to call on boys more than girls. • Don't permit boys to demean girls' work or ability in math, science and technology either verbally or behaviorally. • Teach the workshops to girls, too, or to parents. • Make a presentation on the project to the School Board to make them aware of the gender gaps in computers, science and math. And hundreds of others, which I hope to publish this year.

The hallmark of the strategies was rather simple: take virtually any specific step to encourage girls to persist in technology, math or science.

Merely saying to a girl, "You know, you're very good at this. You really should take XYZ course," is quite an effective strategy.

In the middle of this 18-month period, we had a three-day follow-up meeting for all 200 trainers together in New Orleans, home of Dixieland jazz. *The trainers* taught the sessions, not the project staff, although we arranged for outside speakers. There was also a good deal of time built into the schedule for trainers to discuss common situations and concerns among themselves.

The last major element of the project was our newsletter. We published six issues in all, ranging from four pages (the first) to 40 pages (the last). Newsletters consisted primarily of information about the trainers' activities, obtained via telephone interviews with them and frequent informal mail and phone contacts: strategies they were carrying out, presentations on gender equity in math, science and/or technology they made beyond their schools, tips for successful workshops and computer equity team meetings, awards and honors, press mentions, especially good trainer quotes, and in the last two issues, "triumphs" -- the wonderful results we sampled at the beginning of this paper. All entries identified the trainer of origin. We also included occasional research notes, resource suggestions, miscellaneous news items, and as many jokes and cartoons relating to our themes as we could find.

In the final analysis, only three trainers of the 200 failed to teach even one workshop, and only 17 percent did not carry out strategies beyond teaching the workshops. All the others carried out programs that involved girls in a few or a lot of strategies, which led to the triumphant statistics. In addition, 71 percent of the trainers gave additional presentations on gender equity in math, science and/or technology beyond their immediate schools -- local, state or national professional meetings, other schools in their districts or elsewhere, parent and community groups, and others. (I would like to emphasize that these extra presentations were entirely voluntary, not at all

required by the project.) Many of the trainers have told us they are "hooked for life."

ACCOUNTING FOR THE PROJECT'S SUCCESS

I have thought a great deal about the factors that account for the project's stunning success. What made this one work so well when educational equity projects so often have much more limited impact?

The Seminars

- INTENSE SCHEDULE. The six days of the seminar were full to bursting, with trainers working hard from 8:45 AM to 5:00 PM. The experience therefore was intense, reinforcing the power of the message.
- MULTIPLE INSTRUCTORS. The fact that we had five instructors, all carefully chosen for their teaching ability as well as their expertise, mattered. As one trainer said, "I began to believe it when I heard the same thing coming in different ways from all of you." The five instructors also helped to vary the pace and format over the week, since all the sessions were different.
- NO MALE-BASHING. I refused to permit male-bashing, and for several reasons. First, it is simply not true that male teachers are the problem and female teachers are the solution -- there is plenty of evidence of helpful men and sexist women. Second, male-bashing effectively releases men from responsibility for gender equity problems in their schools. Third, a fifth of the trainers were men and insulting males would have alienated them.
- NO BLAMING. I told trainers from the beginning that the gender imbalances in their schools were not their fault. They did not create the problem, although they inadvertently contributed to it like everyone else in a sexist society (including myself), but it was in their power to fix it. Even though my assertion that they did not *cause* gender inequity may technically have been a lie concerning a number of trainers, it was a necessary and constructive lie. And it eventually became true.

- RELAXED ATMOSPHERE. To counteract the tension created by questioning sex roles – this can be very sticky for some people! -- and the hours of hard work, I and the other instructors were informal, laughing and joking whenever we could. I deliberately created a warm and casual atmosphere in which trainers could feel welcome and comfortable.
- OWNERSHIP. I emphasized that the workshops they were to teach, although I had written them, were theirs to adapt as they saw fit, that there was not one "right" way -- meaning *my* way! -- to teach them. Similarly, I urged them to develop their strategies as they felt best in their particular circumstances.
- GEOGRAPHIC QUADRANTS. Organizing seminars by geographic region gave trainers something in common and maximized the likelihood of future contacts among them.

After the Seminars

- NEWSLETTERS. The newsletters served as idea source, reward for ingenuity, effort, and work well done, and quite frankly peer pressure. Trainers wanted to see their names in print, and to do that they had to achieve something.
- THE FOLLOWUP MEETING. Trainers loved coming to New Orleans (which is why we chose that location) and meeting their old friends plus 150 new ones who had had the same experiences they had. They also were proud of being the experts for this meeting.
- FREQUENT CONTACT. We sent out many mailings, including the newsletters and various other pieces of information and reminders. We encouraged trainers to call us and we called them. When they mailed us news of their doings I wrote a personal note of congratulations.

Overall

- MONEY. The large budget enabled us to attract trainers who would not otherwise have been interested in a gender equity project and to pay the fees and expenses of nationally known instructors. It also supported three

full-time staff members, making possible the extensive followup contacts and the time-consuming newsletter preparation.

- EXPECTATIONS AND REWARDS. The high expectations of performance -- hard work at the seminars, achievement in their schools -- was balanced by abundant praise rewards in the form of notes and phone calls from staff and of newsletter entries. Trainers may also have been somewhat motivated by the small cash awards at the end of the project.
- SHARED PURPOSE. The creation of a shared purpose, a group feeling -- a sense of "we-ness" -- meant that the project was *their* project, not done *to* them. By fostering group cohesion at the seminar and enabling trainers to share their expertise with each other in the followup meeting and the newsletters, we ensured that trainers gained ownership of the project.
- RECOGNITION. Last, K-12 educators in the United States are often not recognized for the good work they do. The trainers' participation in a high-visibility national project, expense-paid trips to California or Massachusetts and to Louisiana, the opportunity to do something different and to meet colleagues from the rest of the country -- all were signals that they were professionals worthy of, and earning, respect.

I hope these reflections will be encouraging and useful to you. You, too, can change the world for women.

GENDER, COMPUTERS AND GROUP WORK IN SCIENCE

Eileen Scanlon, Tim O'Shea and Sara Hennessy,
Josie Taylor and Denise Whitelock

Dans ce document, nous décrivons les aspects masculins et féminins de trois projets de recherche auxquels ont participé des femmes et des hommes qui étudient les sciences avec des ordinateurs. Dans le premier projet, intitulé «The Conceptual Change in Science», nous avons tenté d'utiliser des programmes d'ordinateur visant tout spécialement à améliorer les performances en sciences d'un groupe mixte d'étudiantes et étudiants âgés de treize ans. Les concepts étudiés étaient ceux de la mécanique newtonienne. Dans le cadre du deuxième projet, intitulé «SharedARK», les participantes et participants adultes travaillaient en couples dans le cadre d'une simulation du problème de «courir sous la pluie». Dans le troisième projet, un projet informatisé de travail collectif en physique, nous avons examiné la façon de former des groupes pour que la collaboration dans une simulation informatisée en physique conduise à une amélioration maximale de la tâche de prédiction du comportement d'un ensemble de curseurs, conformément aux principes de conservation de l'énergie et du rythme. Ces trois études présentent une hypothèse naissante sur les différences entre les sexes, sur la façon la plus productive de former des groupes pour travailler à l'ordinateur, soit que le sexe influence les conditions idéales pour encourager le travail d'équipe à l'ordinateur. Les filles travaillent mieux ensemble à l'ordinateur, car leurs points de vue correspondent davantage. Les garçons travaillent mieux dans des groupes où l'on observe un conflit socio-cognitif et cette distance sociale est un facteur clé dans l'influence du succès de groupes mixtes.

GENDER, COMPUTERS AND GROUP WORK IN SCIENCE

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ABSTRACT

In this paper we will describe the gender aspects of three research projects involving students working with computers on science topics. The first project "The Conceptual Change in Science roject" was an attempt to use specially designed computer software to improve the science performance of a mixed group of thirteen-year-olds. The concepts to be studied were those from Newtonian mechanics. The second project, the SharedARK project involved adults working in pairs working at a simulation of the "running in the rain" problem. The third project the Computer Supported Cooperative work in physics project investigated how to construct groups so that cooperative work on a physics simulation at the computer would produce most improvement on the task of predicting the behaviour of a set of pucks due to the Laws of Conservation of Momentum and Energy. These three studies present us with a developing hypothesis about gender differences in the most productive way of forming groups to work at the computer. This is that gender influences the ideal conditions for facilitating group work with computers. Girls work best together at computers in groups where their views of the topic are similar, boys work best in groups where there is sociocognitive conflict and that social distance is a key factor in influencing the success of mixed gender groups.

INTRODUCTION

In this paper we describe the gender aspects of three research projects which involve students working with computers on science topics. The first project "The Conceptual Change in Science project" was an attempt to use specially designed computer software to improve the science performance of a mixed group of thirty thirteen year olds. The second project, the "SharedARK" project involved 22 adults working in mixed and single gender pairs working at a simulation of the "running in the rain" problem (de Angelis,1987). The third project the "Computer Supported Coperative Work" in physics project set out to investigate how to construct groups so that cooperative work on a physics simulation at the computer would produce most improvement on a task related to conservation of momentum. This project involved over 80 fifteen-year-old

schoolchildren. In what follows, for each project we will briefly describe the context of the work, report the findings which are gender related, and relate these findings to a developing view of the gender related aspects of working with computers on science simulations.

1.THE CONCEPTUAL CHANGE IN SCIENCE PROJECT

1.1 Context "The conceptual change in science project" aimed to improve the science understanding of a mixed group of thirty thirteen year olds using specially designed computer software . The concepts to be studied were those from Newtonian mechanics. The software consisted of scenarios implemented in DM^3 (the Direct Manipulation of Mechanical Microworlds) computer program written in Smalltalk-80. The computers used were MAC-IIs. Our curriculum involved a scheme of work based round four scenarios ("the Rocket Skater", "the Parachutist", "the Speedboat", and the "Supermarket"). These scenarios were brought to life in simulations which children could use both in structured experiments and in an informal way. The scenarios combine with support materials e.g worksheets to form an integrated teaching package which also includes 'real' practical experiments. All this practical work involves children in pupils firstly making predictions about the outcomes, providing their reasons, and then finally checking the outome against their predictions.

The curriculum was based on a constructivist approach. Starting from pupils' prior conceptions, we aimed to help pupils form new concepts which they could use to interpret their experiences in mechanics. We needed to provide counter evidence to their predictions from experiences either in the 'real' or computer world. On other projects students have been observed to not believe this sort of evidence or to consider it faulty data or forget it quickly and revert to previous beliefs. We believe that learners need an alternative way of conceptualising the problem before being prepared to reconsider their current ideas. The scenarios were constructed to provide opportunities for pupils to construct a Newtonian set of rules for force and motion in a supported software environment, through observation of patterns of events and data on the screen. Learners also needed to assess the validity of their new conceptions by doing

and discussing experiments in the real world. This led to the design decision to incorporate 'real' with computer practicals and the adoption of the Predict/Observe /Explain methodology. So, our purpose was to see whether we could promote conceptual change in a real school setting and make some inferences about the role that the computer software had in effecting that change. We were fortunate to obtain the help and cooperation of an experienced classroom teacher in a local comprehensive school who was prepared to take on board the curriculum we had prepared and allow us to observe the classroom work in progress.

The curriculum occupied 29 children aged 12 -13 for seven weeks. This was a mixed ability class of 13 boys and 16 girls. The clasroom time spent was 5 hours per week with approximately 1 hour homework per week. The children worked in triads, assigned by the teacher. Work was organised so that pupils worked half time on practical work and halftime on the computers. All of our subjects had prior experience of microcomputers and using a mouse. The pupils had no previous secondary level science instruction in mechanics or physics. The data collected involved diagnostic tests, a pre test called "your ideas about motion", which also was given as an immediate post test and then one month later as a delayed post-test. We also collected interviews with individual children, and video and tape recorded transcripts of the children at work together with observer's notes, and copies of homework and the children's completed worksheets.

1.2 Gender findings The class was divided into ten small groups, nine triads and one pair. Our groupwork consisted of seven weeks working in fixed triads on a specially designed curriculum with time equally divided between 'real' and computer practicals. Children worked in affinity groups chosen by the class teacher and were operated for a two week trial period before the main experiment. None of the mixed sex groups set up by the teacher survived this trial run. The effectiveness of the curriculum was measured by comparing individual student performance on a pre and post test and we experienced some significant improvement in pupil performance (See Hennessy et al, 1990, and in press). However, gender did not appear as a relevant variable from the ANOVA . This finding is rather surprising given the previous results

from APU test items (Johnson and Murphy, 1986) However several observers did comment on the different behaviour of the m-m as opposed to f-f groups, with the girls' groups behaving more cooperatively. We currently are reviewing our audiotapes and videotapes of the groups as they worked at their tasks,.to try to characterise these differences. In post experiment interviews, we found that many of the girls preferred conventional to computer practicals.

1.3 Interim hypothesis This project was not designed to investigate gender differences. We made particular efforts to design scenarios which were equally appealing to both boys and girls, and our findings on conceptual change show no particular advantage or disadvantage for boys or girls groups. However, our anecdotal evidence is that the groups behaved differently and this is tune with work by Whitelegg et al on groups working on primary science investigations without a computer.

2. SHARED ALTERNATE REALITY KIT

2.1 Context The second project, the SharedAlternate Reality Kit (SharedARK) project involved adults working in mixed and single gender pairs working at a simulation of the "running in the rain" problem (de Angelis,1987). SharedARK is a prototype technology for allowing students to work together at a distance from each other. In these experiments two users are in seperate rooms with a workstation each and communicate through a high fidelity hands free audiolink with a camera monitor device called a videotunnel which enables eye contact. We used an underspecified problem where subjects needed to decide the precise problem to be solved. The problem of whether to run or walk in the rain without an umbrella was posed Running means spending less time in the rain, but, on the other hand, since you are running into some rain, you might end up wetter than if you had walked.This is a hard problem for a university student of mathematics or physics. If we take the advice given in one formulation of the problem, model the person in the rain as a rectangular parallelepiped and start with the case of vertical rain, it is still necessary to make a set of simplifying assumptions, develop an appropriate model, find a mathematical solution to the model and interpret the solution. ARK (Smith, 1992) is a system for creating interactive

animated simulations implemented in the Smalltalk-80 programming environment and includes some unique features chosen to make its simulations powerful and unique, see e.g. Scanlon and Smith, 1988. With the design of SharedARK, a distributed version of ARK, we were able to experiment with pairs of users who would use SharedARK while communicating from remote locations with an audio and video link. As Open University staff we are particularly interested in the implications of this sort of technology becoming available for distance education institutions.

The Shared Alternate Reality Kit (SharedARK) is a two dimensional plane containing simulated physical objects (Smith, 1992). A user's screen enables them to see a portion of this plane and users can scroll over the two dimensional world. Because two users can scroll to different and arbitrary points on the plane, they may not see the same portion of the world. If their views overlap partially they have access to the same objects, and users can drag their rectangles into coincidence to work with the same objects or can move them apart to work on seperate portions of the task. The objects in SharedARK, as in the original ARK, each have an image, a velocity, mass and the ability to respond to forces. Users each have a mouse operated hand which they can use to press buttons, and to carry or throw objects. At the top of the window is a radar view in which a greater distance is visible. Users can scroll their view regions apart to visit remote parts of the two dimensional plane. At the bottom of the window is a teleporter, which enables users to jump through vast distances without scrolling.

In these experiments the two users are in seperate rooms with a workstation each, and communicate through a high fidelity, hands free audio link and with a camera monitor device called a videotunnel which enables both voice and eye contact. Within SharedARK, after an eight to ten minute introduction to the interface and the task, the subjects were given a microworld containing a rain cloud, a rain runner and a device to control simulation parameters such as the speed and the direction of the rain and the wetness of the runner. During the introduction they are told that the object of the activity is for them to jointly agree when it is worth running in the rain. They are shown how to make the runner wider and narrower, how to make the runner move and

how to switch the rain on and off. Subjects were invited to use the microworld to test their ideas and after 90 minutes they were asked to report on their findings.

We recorded eleven pairs of students using the system. We used two pairs as pilots and this left nine pairs for the main study. Fifteen of the subjects were postgraduate research students with undergraduate training in maths or physics, five subjects have technical jobs with similar education in maths and science and another two have an academic managerial role and were educated to first degree level. The evaluation technique pioneered in this study involved collecting four synchronous video signals made up of what was displayed on the two video tunnel screens and the two simulation screens looked at by the subjects. This video protocol was analysed by relating utterances to both simulation events and eye contact. The utterances were categorised into those related to the interface, the task and those that had a social aspect. These uttereances were then assigned to subcategories called meta-level, specific and repair. Collecting these protocols was very resource demanding, as was making transcripts and devising and applying a coding scheme to the transcripts. However this rich data source has supported a variety of useful findings related to multimedia distributed problem solving. We have described also some features of the dialogue (Taylor et al, in press), and the type of augmented problem solving which was facilitated (Scanlon et al, 1993), but the main result of this experiment was the importance of eye contact through the videotunnel in establishing successful collaboration (Smith et al,1989) quoted below

> The subjects quickly learn to use the SharedARK simulations and come to terms with the shared audio-video-computer space in which they find themselves. The shared space created by this technology places subjects into a kind of enhanced proximity in which it is possible to be simultaneously side-by-side and face-to-face.

2.2 Gender findings In this study with several mixed pairs we were able to notice some gender effects. The proximity relations are such that subjects can be both face to face through the video tunnel and side by side hrough the Shared ARK interface. We originally hypothesised that since being face to face facilitates patterns of mutual gaze,

subjects would be comfortable with this situation and that it would contribute to more productive problem solving. However we have seen subjects who worked together well and subjects who were at times uncomfortable working through the videotunnel. Male/female pairings seem to find the negotiation of their problem solving more successful than male/male pairings. We think this is because in the case of male/female couples, the videotunnel achieves a distancing effect but at the same time preserves the process of gaze negotiation. This enables subjects to relax with one another, increased social distance therefore proving facilitative. In the case of male/male pairs increased social distance may exacerabate latent communication difficulties, a situation they may find difficult to rectify due to lack of acceptable strategies when the only non verbal medium open to them is mutual gaze.

2.3 Interim hypothesis We had four male/female pairings, three male/male pairings and one female/female pair, so we are aware that these impressions are not founded on a large body of data. We would like to collect more female/female protocols to check out how our finding applies to more female/female groups.

3.COMPUTER SUPPORTED COOPERATIVE WORK IN PHYSICS

3.1 Context The third project the Computer Supported Coperative Work in physics project set out to investigate how to construct groups so that cooperative work on a physics simulation at the computer would produce most improvement on our task. This was to make some predictions about the behaviour of a set of pucks using the Laws of Conservation of Momentum and Energy in a computer simulation called *Puckland*. Pupils were pretested with a questionnaire before using the simulation. Then the subjects had access to the simulation where they are given time to check out their predictions and to experiment with any other situations which interested them before completing the problem solving exercises. A post test was then administered.

3.2 Gender findings Our hypothesis was that sociocognitive conflict would improve the performance of the group (as predicted by Howe,1992). We tested this with single gender pairs of 15 year old British schoolchildren. The pairings were formed by analysis of the performance on pre tests of eighty children. Four types of

pairs were formed: boy/boy pairs with similar views of the physics concept , and girl/girl pairs with similar views and two further groups with differing views on the physics. Our finding was that overall all the groups increased their scores on the post test by at least 50%, and surprisingly it is the similar pairs rather than the different pairs which improve the most. 'Girls similar' improved most of all (80% pecentage score increase from pre to post test) with boys similar coming next (70%), with boys and girls different being equal third (~60%). On inspection, the girls similar had the worst scores on their pre tests however. When we examined the dialogues the girls appeared to have less experiential knowledge of collisions than the boys (ie they did not play snooker, hockey or football and did not use analogies form their sporting experiences to make predictions. Further details of this work is available in Whitelock et al, 1993).

3.3 Interim hypothesis From this set of experiments, we were struck by the evidence for the productive behaviour of groups of girls who have similar views of the topic under investigation. This finding goes counter to much previous work on collaborative learning where the importance of sociocognitive conflict is stressed. We were also struck by the evidence that girls were disadvantaged by their lack of practical experience of collisions, a finding which is in tune with previous work (see e.g. Johnson and Murphy).

4.CONCLUSION

These three studies present us with a developing hypothesis about gender differences in the most productive way of forming groups to work at the computer. This is that gender influences the ideal conditions for facilitating group work with computers. Girls work best together at computers in groups where their views of the topic are similar, boys work best in groups where there is sociocognitive conflict and that social distance is a key factor in influencing the success of mixed gender groups. We hope to continue working on experiments designed to test this hypothesis.

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THE UNIVERSITY OF MANITOBA ACCESS PROGRAM FOR WOMEN IN SCIENCE AND ENGINEERING

Barbara L. Sherriff

On demande à des élèves-ingénieures du premier cycle (coordonnatrices d'accès) d'aborder avec les étudiantes et étudiants des classes de la 1re à la 12e années la question des exigences et des possibilités de carrières en sciences et en génie. Entre mai 1990 et juin 1992, des présentations ont été faites à plus de 38 000 étudiantes et étudiants de Winnipeg et des régions rurales du Manitoba, à des groupes strictement composés de femmes et à des groupes mixtes. Nous avons également conçu des affiches et des dépliants sur les sciences pour les élèves.

Le format des visites varie en fonction de l'âge des participantes et participants mais comprend généralement une présentation informative et une discussion. Pour les classes de niveau inférieur, la visite inclut une démonstration scientifique dans le cadre de laquelle les élèves sont encouragés à participer. C'est une façon efficace de stimuler le dialogue ainsi que de démontrer à quel point les expériences scientifiques peuvent être amusantes. Nous avons un «Magic of Science Road Show» incluant une bobine de Tesla, un laser hélium-néon, une boîte lumineuse, des spécimens de sciences naturelles et diverses expériences avec du nitrogène liquide. Les principes scientifiques sont expliqués en termes simples pour démontrer que la science n'est pas quelque chose de «magique» et qu'il est possible d'en comprendre les divers éléments. Les coordonnatrices d'accès, qui travaillent à plein temps de mai à juin et à temps partiel pendant l'année scolaire, sont choisies en fonction de leurs aptitudes à communiquer et de leur enthousiasme à l'égard de leur spécialité particulière. Dans le cadre de leur présentation, elles sont tenues d'expliquer ce qui les a attirées dans le domaine de leur choix et ce qu'elles espèrent accomplir dans leur carrière. Nous embauchons des coordonnatrices de différents secteurs des sciences et du génie, aux antécédents culturels et ethniques divers, y compris des francophones pour donner des présentations en français dans les écoles françaises et d'immersion.

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ABSTRACT

Female undergraduate science and engineering students (Access Coordinators) are employed to talk with students, from grade 1 to 12, about the requirements for, and possibilities of, careers in science and engineering. Between May 1990 and June 1992, presentations were given to over 38,000 students in Winnipeg and rural Manitoba, both to girls alone and to mixed gender groups. We have also produced posters and pamphlets about science for school students.

The format of the visits varies with age group but is generally an informative presentation followed by discussion. For the lower grades it includes a demonstration of science in which the students are encouraged to take part. This is an effective means of encouraging dialogue as well as demonstrating the excitement of scientific experiments. We have a "Magic of Science Road Show" including a Tesla Coil, a He-Ne laser, a light box, natural science specimens and various experiments with liquid nitrogen. The scientific principles are explained in simple terms to show that science is not "magical" but understandable.

The Access Coordinators, working full-time during May and June and part-time during the academic year, are chosen for their ability to communicate and also for their enthusiasm about their particular speciality. Explaining how they became interested in their subject and what they hope to accomplish in their career is part of the presentation. We hire coordinators from different areas of science and engineering and with a range of cultural and ethnic backgrounds including francophones who give presentations in French to Français and French immersion schools.

INTRODUCTION

The Access Program for Women in Science and Engineering was established in response to the low numbers of women, both students and faculty, in engineering and the physical sciences at the University of Manitoba (Table 1). Any increase in these numbers is alarmingly slow. Female undergraduate science and engineering students

(Access Coordinators) are employed to talk with students, from grade 1 to 12, about the requirements for and possibilities of careers in science and engineering. Between May 1990 and June 1992, presentations were given to 38,636 students, 21,598 of whom were women, in 443 school visits in Winnipeg and rural Manitoba, both to girls alone and to mixed gender groups.

The coordinators and faculty advisors to the program have also given talks, often as keynote speakers, at school career days, at provincial career symposia, at school science and technology events, to school counsellors at inservice days and to students in the University of Manitoba Faculty of Education. They have given interviews to the press and on radio about careers for women in science and engineering, demonstrated science on a children's television show and acted as judges at many school and regional science fairs.

With the assistance of a graphics artist and a copywriter we have designed and printed posters and pamphlets which present science in an interesting and dynamic fashion to elementary, junior high and high school students.

FUNDING

Operational budget allocations of a total of $155,500 for the program to operate from 1990 to 1993 have been provided by the Manitoba Universities Grants Commission. Additional support was obtained from Manitoba Careerstart ($3,740), the Faculties of Science ($8,000) and Engineering ($8,000), the Association of Professional Engineers of Manitoba ($2,200) and a donation ($5,080). In June 1991 we were awarded $6,500 as a major outreach award from the University of Manitoba to produce a "Magic of Science Show" for elementary schools.

PERSONNEL

The Access Coordinators are chosen for their ability to communicate information about science and engineering and also for their enthusiasm about their particular speciality. Explaining how they became interested in their subject and what they hope to

accomplish in their career are integral parts of the presentations. Using undergraduate students has the added advantage that senior high school students do not perceive an age difference between themselves and the coordinators and are more willing to join in discussions with "peers" rather than with an "adult" teacher or scientist. We try to hire coordinators from different areas of science and engineering with a range of cultural and ethnic backgrounds. Francophone coordinators give presentations in French to Français and French immersion schools. From October to December 1990 a native civil engineering student was seconded to us by the Engineering Native Access Program to visit schools with high native populations.

During the summer of 1991 the Access program collaborated with the University of Manitoba Mini-University children's camp with students being hired as instructors for the science components of the Mini-University in but spending part of May and June visiting schools as Access Coordinators. Other Access Coordinators were hired as Mini-University Assistants in July and August, 1991 and 1992. The effect on the students of seeing women scientists in their schools is reinforced by seeing the same women in their roles of scientists in the university environment.

The program is jointly supervised by volunteer faculty advisors from the Faculties of Science and Engineering.

SCHOOL VISITS

Principals and guidance counsellors of schools in both Winnipeg and rural Manitoba are contacted by mail each year. We initially request to speak to groups of girls alone but also indicate that we are willing to meet with mixed groups if the school prefer. As many of the schools are reluctant to segregate the girls, the presentations are more frequently given to mixed groups.

The coordinators work full-time during May and June and part-time during the academic year from September to April. The format of their visits vary with the age group but is generally an informative presentation followed by discussion. Initially the

primary target groups were girls in grades 7 to 10 where the goal was to encourage them to remain in the university entrance science and mathematics stream. As the program progressed we realised that it was just as important to foster an interest in science by the children of both genders in lower grades and to explain university programs and career possibilities to students in grades 11 and 12. Therefore the program has been expanded to include grades 4 to 12, with the occasional presentations being given to younger students in rural Manitoba. A science demonstration is included in all the elementary school presentations.

During the university academic year, time constraints of the coordinators, who are all full time students, limits the school visits to Winnipeg and the immediate surrounding area. However, during May and June the coordinators visited schools across southern Manitoba and as far north as Thompson. Financial restrictions prevent the program from reaching communities further away although we have had requests from as distant as Lynn Lake and Churchill. Since the rural schools have fewer guest speaker opportunities, both students and staff in schools remote from Winnipeg are usually very receptive to the program.

RESPONSE FROM THE STUDENTS

There is a common belief that science and mathematics are not learned but are solely a natural ability given to a few brilliant people. Students think that only those with exceptionally high natural intelligence can succeed in these areas and that working hard has no bearing on success in or understanding of science. Although girls are not generally actively discouraged from pursuing science and engineering, they are not usually presented with these career options as readily as are the boys. Also boys are taking responsibility at a much earlier age than girls for their future career plans.

There is a prejudice, which increases from grade 7 to 9, against physics, which most students believe to be difficult, boring and not essential. They have the same distaste for mathematics, but view it as a necessary subject. Many boys continue with

physics at grade 10 because they are not as intimidated by the mechanical nature of it and understand the importance of physics to their future careers, whereas girls consider biology to be more relevant and therefore forego physics. In the presentations, it is stressed that physics is necessary for many science and all engineering programs in university, whereas high school biology, though important, is not a prerequisite even for biology programs.

Students of all ages have little or no understanding about careers in engineering. The impression they have of engineering usually is of a manual "blue collar" occupation involving either construction work or fixing or driving engines. Very few students understand that engineers are involved in design. Ideas of scientists come from comic books or movies where they are portrayed as "mad", with "weird hair", a white coat and glasses or as evil geniuses. Very few students know that scientists are professional people who do research. Most students have only male images of both scientists and engineers. The coordinators try to dispel these images of scientists and engineers both in their presentations and by example.

Elementary school students give the coordinators an overwhelmingly positive reception and seem to be genuinely interested in science. The coordinators speak to a few groups of children from kindergarten to grade 3 in small rural schools. The presentation for this age group is extremely short and has a "show-and-tell" format. These children while being receptive to ideas, have limited ability to grasp any of the scientific concepts illustrated in the demonstrations.

For grades 4 to 6 a fifteen minute talk is followed by a series of science demonstrations and displays in which the children are encouraged to participate. The interest in science is especially keen in grades 4 and 5 but is somewhat more varied at the grade 6 level. There is a spontaneous interaction with the students asking questions without any provocation. Occasionally the boys dominate this interaction by asking more questions and monopolising the "hands-on" demonstrations.

Junior high students, in grades 7 and 8, know much more about science than the elementary students but usually their interest in science has noticeably waned and many students, especially girls, have decided by grade 9 that science is not for them. There are a few highly motivated groups who have teachers who are enthusiastic about science.

Students in grade 9 and 10 are unequivocally the least receptive of all the age groups and display little or no interest in the presentations. This may not be entirely a reflection on the subject material, since at this age it is not "cool" to show an interest in anything. These students are inflexible as to what they are not interested in. If they have decided that physics and mathematics are boring and far too difficult, it is nearly impossible to convince them otherwise. This age group is crucial to influence, since in grade 10 students decide whether or not to take university-stream physics.

Many of the grade 11 and 12 students addressed are already taking university entrance science and math courses. Grade 12 students, who have already applied to university and are looking for some first hand guidance, are a very receptive audience. They appreciated having university students of about their own age speak to them and answer questions about experiences and conditions in university. Few of the female science students have considered engineering programs, due to lack of information.

RESOURCE MATERIAL

Pamphlets and Posters

We found, when visiting the schools, that there was a shortage of pamphlets and posters explaining science in a manner suitable for grade 5-12 students.

Posters were produced, with the aid of a graphic artist for distribution to elementary, junior high, and high schools. These show students the possibilities and necessity of science. Pamphlets, which are visually coordinated with the posters, were designed for junior high and high school levels. They explain in more detail about careers in science and engineering and the requirements to enter these programs at university. We are not producing pamphlets for the elementary schools as this age group

are unlikely to read them. All of the images on the posters and pamphlets are female to reinforce the message that women as well as men are scientists and engineers.

The pamphlets and posters are being distributed to schools during visits by the coordinators and also at the request of the schools.

Science Demonstrations

The presentation to lower grades includes a demonstration of science in which the students are encouraged to take part. This is a very effective means of encouraging dialogue between coordinators and students as well as showing the students some of the excitement of doing scientific experiments. An outreach award from the University of Manitoba enabled us to produce a "Magic of Science Road Show" for elementary schools. The demonstration includes a Tesla Coil, a He-Ne laser, a voice transmission package, a light box to demonstrate the principles of optics, a slinky to demonstrate vibrational waves including seismic waves; natural science specimens such as rocks, minerals, animal bones, H_2O_2 added to fresh liver to induce an enzyme reaction and various experiments with liquid nitrogen. In each experiment the scientific principles are explained in simple terms to show that science is not "magical and mysterious" but understandable.

SUMMARY

At every grade level, there is an almost complete ignorance of careers in science engineering, not only by students, but by guidance counsellors and teachers. Female students who are taking physics and math are not even told that engineering is a viable career option and are given little information about careers in science. There is a poor image of scientists as either social misfits or geniuses. Only the top female students are ever encouraged to take physics and to pursue a career in science.

Students from engineering and science, or professional women visiting schools to speak to young people are likely to have the greatest effect on student interest these careers. A speaker can answer specific questions, respond to the tone of each group, and

emphasize particular points. Visits personalize these professions, as nothing is more vibrant or motivating than informed speakers who are interested in their chosen careers. Also, nothing emphasizes that this is a viable career option for women more effectively than having a first exposure to a profession from a woman.

The response from students, counsellors and teachers is that the program is fulfilling a need to educate them all, including the teachers and counsellors about opportunities for women in science and engineering. Many schools have asked us to return to speak to the same students as they proceed through the grades to reinforce the message and also to speak to the parents.

We have grown from a very small beginning, with just two coordinators originally hired for one summer, to a successful program continuously running for three years. There have been substantial increases in the number of women entering engineering in the past years from 11.2% of the first year enrolment in 1990 to 19.7% in 1992. The increase in numbers in science will be slower to appear as the grade 9 and 10 students who are our primary target are only just reaching entry into university.

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TABLE 1: GRADUATES FROM THE FACULTY OF SCIENCE

	Four-year totals: 1987-91				Four-year totals: 1983-86			
	F	M	T	%F	F	M	T	%F
B.Sc.Majors and Honours								
Math. Sciences	69	83	152	45%	51	94	145	35%
Phys. Sciences	17	92	109	16%	27	156	183	15%
Biol. Sciences	109	151	260	42%	93	126	219	42%
Comp. Science	48	269	317	15%	149	548	697	21%
Graduate: M.Sc.								
Math. Sciences	7	14	21	33%	5	18	23	22%
Phys. Sciences	8	55	63	13%	7	75	82	9%
Biol. Sciences	25	36	61	41%	17	47	64	27%
Comp. Science	7	67	74	9%	10	51	61	16%
Graduate: Ph.D.								
Math. Sciences	1	9	10	10%	0	3	3	0%
Phys. Sciences	7	28	35	20%	4	24	28	14%
Biol. Sciences	8	13	21	38%	4	16	20	20%
Comp. Science	0	7	7	0%	0	4	4	0%

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OPEN DOORS: THE HISTORY, IMPLEMENTATION AND EVALUATION OF A ROLE MODELLING PROGRAM

Jean Surry, Marjorie Sheasby, Janet V. Collins and Tracy Baker

En 1984, le gouvernement de l'Ontario a donné naissance à six projets en demandant à des femmes occupant des postes non traditionnels de jouer le rôle de modèles à imiter dans leurs collectivités respectives. Le gouvernement a prié ces femmes de s'adresser aux étudiantes et étudiants pour leur parler de leur carrière, dans l'espoir d'éveiller leur intérêt sur la vaste gamme de professions disponibles et de réduire le nombre de choix traditionnels. Dans ce document, on aborde l'historique et l'évolution de ce programme dans la région de London (Ontario), depuis ses débuts, en passant par l'hypothèse de propriété locale en 1988 et d'incorporation officielle, jusqu'à aujourd'hui. On aborde dans ce document les difficultés auxquelles on se heurte pour créer un organisme de services professionnel viable fondé sur le bénévolat. La liste des conférencières demeure la principale ressource et le document fait état de la mise à jour de cette liste. Pour assurer un usage répandu des services, on communique régulièrement avec les trois conseils scolaires régionaux et les bénévoles sont encouragés à participer aux journées pédagogiques du personnel enseignant, aux journées de scolarité et aux activités communautaires. On y parle également des éléments contributifs suivants : un panneau d'exposition avec photographies et messages promotionnels; une variété de dépliants informatifs. Voie nouvelle, un programme qui permet aux étudiantes et étudiants du palier secondaire de suivre une étudiante ou un étudiant d'une université ou d'un collège; et une exposition d'affiches. Après quatre années au niveau local, le succès et les défis continuels du programme *Open Doors of Greater London* sont examinés.

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OPEN DOORS : THE HISTORY, IMPLEMENTATION AND EVALUATION OF A ROLE MODELLING PROGRAM

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Abstract

In 1984, the Ontario government originated six pilot projects by asking women who were employed in non-traditional occupations to act as role models in their respective communities. They were asked to speak to school students about their careers, in the hope that this would raise awareness about the wide variety of available careers, and reduce stereotypical choices. In this paper, the history and growth of the program in the London, Ontario region are traced from this beginning, through the assumption in 1988 of local ownership and formal incorporation, to the present. The difficulties of establishing a viable, professional service organisation based on volunteers are addressed. The Speakers List is still the prime resource and the paper reports on its maintenance. To ensure wide usage of the service, contacts with the three regional school boards are vigorously pursued and volunteers are encouraged to participate in teachers' professional development days, school career days and city-community events. The contribution of the following are also addressed: a Display Board, with photographs and promotional messages; a variety of informational pamphlets; Pathmakers, a program which allows a secondary school student to shadow a university and/or college student; and a poster exhibition. After four years of local operation, the success of and continuing challenges to *Open Doors of Greater London* are explored.

Introduction

This paper describes the growth and evolution of the voluntary community agency known as *Open Doors of Greater London*. Throughout this paper, the collective term *Open Doors* refers to the organization itself, its executive and membership, and its programs and community outreach. The paper describes the origin and mission of *Open Doors*, its activities in the four years since its local inception, several socio-political, legal and financial issues, its effects upon the local community, and some challenges encountered.

Early Development of the *Open Doors* Program

In 1984, the Ontario Women's Directorate (OWD) established six pilot projects to support the new career guidance policy of the educational community. The Ontario Ministry of Education required that all students be provided with "information to make realistic

occupational choices" and "opportunities to become aware of the possible influence of social and economic conditions and predictions of future trends on career planning". It was recognised that such information was not readily available for non traditional careers and, in particular, for women's opportunities (Canadian statistics showed that men dominated in 480 out of 500 occupational categories). London became the centre for one of these projects when several women with careers in the sciences, technology, trades and business were contacted and volunteered to be on a registry. For three years the OWD administered the London "Open Doors" registry and distributed it throughout the region's schools, to encourage teachers to contact women willing to speak to students (male and female) about their alternative careers. There were introductory workshops for teachers, the volunteer role models were given training and instructive literature, and the project was expanded as demand increased from the initial 12 year-olds to all ages. When the Directorate offered transitional financial support for those communities that would take local responsibility for their project, a small group of Speakers accepted the challenge and *Open Doors of Greater London* * was founded in 1988.

Open Doors has, from its inception, been conceived as a community venture. In order to carry out its mission to the community its aim has been to recruit the widest possible network of contacts, resources and support. Initially this was done by introducing the concept not only to potential volunteer recruits, but also to a broad range of executives in London businesses, local politicians, and leaders in primary, secondary and tertiary education. During two meetings hosted by 3M Canada Ltd., the fundamental mission, objectives and goals of *Open Doors of Greater London* were developed. The mission remains "to encourage the opening of young minds to the career opportunities which transcend barriers relating to gender, cultural attitudes, economic limitations or other limiting resources." The objectives are "to provide information to elementary and secondary school students, counselors, administrators and parents; to reinforce the concept of full equality of opportunity for children; and to encourage the choice of non-traditional careers through exposure to role models". The initial goals

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* For reference, the term "Greater London" implies the city of London, Ontario, and the surrounding county of Middlesex. The population of the geographic region served is about three hundred thousand. The target group of *Open Doors* comprises three publicly funded boards of education, including one Roman Catholic, one urban and one rural, which are responsible for the education of 120,000 children between the ages of four to about eighteen years in 160 schools.

were to expand the Speakers List, to increase the publicity to school board administrators, to participate in teacher training, and to develop special projects for public display.

Early in the transition it became clear that financial support would be limited unless benefactors received recognition of their donations as charitable contributions. In order to seek formal recognition as a charity under the Income Tax Act of Canada, it was decided that *Open Doors of Greater London* should incorporate as a nonprofit corporation. In the two year process, the executive have become less naive about bureaucratic complications and the need for legal assistance.

Program Activities

The *Open Doors* members have designed and implemented a number of strategies to support the mission statement and objectives, including development of the Speakers List resource, acquisition of a Display Board, initiation of a role modelling programme called Pathmakers, publication of informational pamphlets and sponsoring a poster exhibition. The first project was the recruitment of more role models ("Speakers"), including males and varied socio-cultural representatives and a wider range of alternative careers. In the early years of the project, training nights were held to enable new Speakers to become more effective in discussing their careers with groups of young people. Corporate sponsors have supplied paper and printed up to 2000 copies of the Speakers Lists per year, which have been distributed to teachers through the three Boards of Education. The 1992 Speakers List contained the names and telephone numbers of one hundred and ten speakers in nine occupational categories. A survey of all speakers revealed the number of engagements per speaker in 1991-92, in the following categories: Business and Finance (1.4), Communication and Arts (6.7), Computer Technology (1), Law (11), Health Care (2.6), Public Service (n.a.), Science (2.3), Engineering (5.0), Trades and Technology (5.0). The average number of presentations per speaker per year was 4.2, with audiences ranging in size from thirty to one hundred persons. The total outreach per year is about 20,000 student contacts.

The second major endeavour of *Open Doors* was the preparation of a visual Display Board containing large, coloured photographs of several members of the Speakers List

surrounded by the tools of their respective occupations. Available to schools for use during Career Days and School Open Houses, the 12 by 6 foot Display was on view in 20 schools in 1991-92. In the same year, it was used to enhance a dozen Speakers' panel presentations to educators and was also shown at various public events, for a total exposure of forty five days.

The extension of *Open Doors* known as Pathmakers is designed to provide secondary students (ages 14-18) with the opportunity to examine alternative career preparation programs at post-secondary institutions. Secondary students are matched for one-day visits with second year post-secondary students (the Pathmakers), who are enrolled in courses which are non-traditional for women within the faculties of Science and Engineering Science at the University of Western Ontario, and within the School of Technology at Fanshawe College. A questionnaire and other informational material have been published and are distributed with material from OWD. Two anticipated outcomes of this program were firstly, that secondary students would become more knowledgeable about campus life in areas where women are under-represented. Secondly, the *Open Doors* group anticipated that the Pathmakers project would be taken over by the post-secondary institutions as a regular component of their secondary school liaison programmes. In its most active year, 122 young people from eight London high schools registered for the Pathmakers program.

Other pamphlets produced by *Open Doors* include Educational Resources for Career Choices, which introduces the aims and methods to teachers and administrators; Message to Parents, which supports parental encouragement in the areas of math, science and technology for their daughters; and Your Future, a message to students which addresses the need of all young people to take full advantage of the career options open to them. All promotional materials have been endorsed by the local boards of education.

The most recently instituted activity is a career poster exhibition aimed at 11 year old students. Guidelines for the exhibition require a focus on careers not traditionally pursued because of gender. Female and male participants choose 3-5 careers that start with one letter of the alphabet and create a poster illustrating their artistic impressions of these careers. Exemplary posters selected by a panel of *Open Doors* members are displayed at a local shopping mall during annual provincial Education Week activities.

All the activities described above are now well established. The ever creative members are now developing and considering various new activities to further meet the objectives of *Open Doors*.

Measures of Program Success

Program success may be defined as enhanced recognition and increased usage by the appropriate customer groups at low public cost. Success of *Open Doors* projects are related to various factors: because it is founded on volunteer effort, the various services are free for the teacher; the community services and projects are highly professional in form, content and method of delivery; and, the *Open Doors* concept, mission and objectives receive regular public approval from senior educational and governmental administrators. The program and its message are increasingly recognized within the local community where it has received considerable favourable public exposure.

Open Doors focuses on students at various critical maturation stages, when they gain competence in those subject areas which will facilitate the widest range of future life skills. To reach the full range of students, it has been most productive to gain and maintain support from key trustees of the local school boards, as well as from the directors, superintendents and program heads. Good working relationships have been developed with personnel responsible for guidance/resource programs. These contacts have facilitated meetings with principals and heads of subject and guidance areas at the school level, to introduce the organization, services and printed materials available through *Open Doors*. Introductory video materials provided by OWD have been used extensively. Such outreach requires continuous annual renewal as the personnel change swiftly in some areas.

Once good direct rapport with the teachers and their associations was established,, *Open Doors* has become a regular contributor to annual professional development days. In one successful format, a moderated panel of four speakers tell of their various nontraditional career paths and the impact on their personal lives. Enhanced by the Display and by clips from various OWD and other videos, the presentation triggers a lively dialogue with a typical audience of teachers.

Contacts between the Speakers and students arouse a curiosity about the alternative careers. Students respond differently at different maturational ages, but all enquire about education requirements, remuneration, and specific job activities. Students are often reticent to ask, but are quick to react to, references to integration of career with family life. Informal discussion with students after the presentation invariably indicates enhanced knowledge of a new career option and an excitement about wider possibilities.

Success of young people's efforts to move away from traditional roles also depends on social acceptance by employers, peer employees, parents, siblings and spouses. To spread the *Open Doors* message to the general public, the Display, which won a "best educational award" in its first year, is now annually shown at the regional fall fair, where it has the potential to reach 300,000 people. It has been staffed for ten days in each of the years 1986-'92 by a roster of Speaker - Members. In 1991-'92, 1500 "Be All You Can Do!" buttons supplied by OWD were distributed, together with pamphlets. In discussions initiated by the public, a significant change over four years has been observed in the degree of aggressive reaction and in the level of recognition of the relevance of the *Open Doors* message to females, and also to males interested in alternative careers.

The degree to which a program can raise funds for its support is a further measure of success. Maintenance of viable and dynamic *Open Doors* projects requires considerable financial resources, both in dollars ($6000) and in an equivalent in-kind supply of service and materials (conservatively estimated to be $54,000 annually). Initially, the Ontario Women's Directorate provided seed money to initiate the Speakers List and other pamphlets, the Display, and Pathmakers - projects that allowed us to establish high quality resources for teachers. The Directorate also facilitated two significant social events in 1990 and 1991, at which individuals representing the various supportive community organisations, institutions and corporations were recognized. For continuing success such financial resources had to be found locally. The City of London now allocates an annual grant to *Open Doors* to assist with participation at the regional fair. Leading members of the London business community encourage their employees' participation by releasing some members of the Speakers List for speaking engagements without loss of pay, and by assuming the cost of printing various

publications. The University of Western Ontario and Fanshawe College provide facilities, staff and student liaison. The school boards, whose students benefit from the *Open Doors* projects, provide similar in-kind support. A teachers' federation has demonstrated its support by financing an upgrade of the Display Board. Lastly, while discussing the donation of resources, the extraordinary level of contribution of time by the speakers and volunteers (about 2700 hours annually, usually without remuneration) should not be underestimated.

The program expenses can be divided into two categories: those allocated for specific projects, as above, and those required for infrastructure maintenance. The major operational expenses for *Open Doors* included legal fees for incorporation, mailings and liability insurance for Speakers while engaged in *Open Doors* functions. Although fund raising has become more difficult due to the current economic situation, some organizations are still willing to fund specific projects. However, few donors have been found to support the program's operational costs on a ongoing basis. Given this, it is extraordinarily difficult to maintain secretarial services and administration of professional quality. Fortunately one school board now provides some secretarial service.

A common measure of success is the estimated dollar value required to meet a program's objectives. It is revealing to inspect the cost per contact with each student: the real costs are about $0.30 per contact, and if a dollar value is put to volunteer time and in-kind contributions ($54,000, see above), this increases to $3.00. It is further estimated that about 30% of the students from Grade 6 to 11 are reached each year, while 8% (25,000) of the total population of the region meet *Open Doors* members.

The program is also beginning to reach out and assist other communities: The Minister Responsible for Women's Issues has recently remarked that materials from *Open Doors of Greater London* are being used in "promoting and encouraging the creation of new role-modelling programs". This paper itself is presented by a member of *Open Doors* because sharing the experience with others is part of the group's mandate.

There are several areas in which this *Open Doors* project can be considered a success: broad-based network support with the educational administrators and teachers; increased

student awareness; increasing contact with the general public; the acquisition of financial or in-kind resource support; a very economical cost to reach each student; and, the sharing of expertise with other communities interested in similar role-modelling projects.

Program Challenges

There are a number of areas that have challenged the *Open Doors* executive since the program was taken over locally four years ago:

i) Reaching out to the hundreds of school executives and administrators within the region who control the access to teachers and students, requires considerable effort and time, and must be repeated every year or two as personnel change.

ii) Recruitment, annual revision and publication of the Speakers List pamphlet is a demanding task for a volunteer agency. Continuous recruitment is essential due to the dynamics of professional and family commitments of the members.

iii) The promotional materials require regular revision and reprinting.

iv) The Pathmakers program has not yet been integrated into regular post-secondary school liaison programs.

v) Teachers and students both have a tendency to select the more familiar of the career options, thus somewhat defeating the purpose of the nontraditional offerings.

vi) A more analytic method of evaluating success in modifying the students' perception of their career options could be usefully developed.

vii) The founding members of *Open Doors* originally established a non-hierarchical structure for the committees. However, when a constitution and identification of administrative officers were required for incorporation purposes, this seemed no longer viable. Since the change to the traditional hierarchical structure, the membership seem less "involved" and "committed". This observation needs investigation.

viii) As with all volunteer organizations, *Open Doors* is no exception in requiring continuous effort to raise funding. In particular, support for infrastructure costs is necessary.

ix) We have had to respond to various political queries. When acquiring our status as a registered charity we were notified that we might be suspected of being "a political

lobby group": The use of the word "educate" was considered possibly subversive! Since we were continuing a provincially initiated program this seemed unlikely and legal advisors resolved this with the federal government.

x) The public often poses sociological challenges: are we threatening family values; do we reject "traditional" career choices; are we advocating displacing males from their jobs; does the program discriminate against boys? We have learned that care must be taken to listen for the questioner's true concerns and to respond honestly but with sensitivity to their perspective. We have always successfully demonstrated that we support both females and males in alternative careers, and that we recommend wide open career options to permit a variety of choices throughout a person's life.

Closing Remarks

The founders of *Open Doors of Greater London* were fortunate to have a clarity of purpose and direction combined with unfailing support from the Ontario Women's Directorate. Over its first four years the program has moved quite successfully towards self-sufficiency rooted in the local community. The young people of the Greater London region are well served by *Open Doors* which gives them a greater perception of non-traditional career opportunities.

MAKING WOMEN'S VOICES HEARD IN THE CLASSROOM: AN ISSUES APPROACH TO SCIENCE

Karen E. Tarr

Les premières recherches ont suggéré que les jeunes femmes étudiant les sciences à l'école secondaire avaient tendance à faire une distinction entre leurs connaissances d'un sujet et leur aptitude à maîtriser les notions spécifiques d'un domaine particulier. De façon typique, les méthodes pédagogiques auxquelles a recours le personnel enseignant des programmes de sciences du secondaire mettent largement l'accent sur l'enseignement d'aptitudes discrètes, nécessaires aux élèves pour progresser au niveau d'études supérieur. Les méthodes pédagogiques employées et les aptitudes enseignées ont tendance à rendre l'information inaccessible à un grand nombre de femmes. Il est devenu clair que différentes gens préfèrent différents styles d'apprentissage, selon leurs perceptions du monde qui les entoure. Il est possible que les femmes aient des besoins spéciaux en matière de style d'apprentissage, et que ces derniers ne soient pas satisfaits dans les programmes de sciences actuels.

Ce document traite du besoin de modifier les méthodes pédagogiques et le matériel didactique principal utilisé dans les programmes de sciences. La recherche et l'expérience personnelle soutiennent la nécessité que les enseignantes et enseignants encouragent l'expression accrue des pensées et des sentiments, afin que les étudiantes se considèrent plus averties dans le domaine des sciences. Par conséquent, on suggère d'intégrer une approche des questions fondamentales scientifiques dans les programmes de sciences du palier secondaire.

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MAKING WOMEN'S VOICES HEARD IN THE CLASSROOM: AN ISSUES APPROACH TO SCIENCE

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ABSTRACT

Initial research has suggested that girls in high school science programs tend to distinguish between their knowledge of a subject and their ability to master specific skills within a subject area. Typically, teaching methods in high school science courses have tended to focus predominantly on the teaching of discrete skills necessary for students to advance to higher levels of study. The teaching methods used and the skills taught have tended to make information inaccessible to many women. It has become clear that different people have preferred learning styles based upon their perceptions of the world around them. Women may have some distinct style needs that are not currently being met in the high school science programs.

This paper addresses the need for intervention in the teaching methods and primary materials of science education. Research and personal experience have supported the need for teachers to promote increased vocalization of thoughts and feelings in order for female students to feel knowledgeable about science. For this reason, an issues approach to science is suggested for incorporation in high school science courses.

INTRODUCTION

One of the biggest problems facing Education today is the retention of women in the high school science programs. High school is a critical stage for women. They are at an age where they are questioning what exactly it means to be a woman. Many of them are seeking for a role in

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society and a way of understanding the world around them. They are also being required to make decisions that will effect the rest of their lives, their job options and earning potential. Somehow women are feeling that their needs are not being met in our high school science classes. All students are required to take science in their first two years of senior high. However many women are dropping science after fulfilling their required courses. Our existing system is failing to encourage and retain women in the pursuit of scientific knowledge or scientific occupations.

A consideration of women's methods of acquiring knowledge is central in addressing the issue of women's involvement in the sciences. Current research on learning styles suggests that there are four predominant ways of acquiring information ; concrete sequential, concrete random, abstract random and abstract sequential.(Butler,1987) Clear gender distinctions are not apparent however it is significant that a concrete sequential teaching approach still predominates in the sciences. Concrete sequential teachers and learners are characteristically "practical, predictable, to-the-point, organized and structured" (Butler, 1987). The majority of students find it difficult to learn or maintain interest if the exclusive style used by a teacher is concrete sequential. Butler's research has revealed that style flex is necessary to bridge to the needs of students who tend to perceive in an abstract way and to order their world in non-sequential fashion.

In terms of teaching techniques, concrete sequential teachers tend to focus on note-giving, textbook assignments, and worksheets. Evaluation tends to occur predominantly through factual recall testing and "lab write-ups". The concrete sequential teacher sees the product as more important than the process and tends to maintain a teacher-centered classroom. Students are rarely encouraged to engage in active discussion with each other and/or the teacher. Group work is restricted to labs and usually involves a pooling of "information" not ideas. Generally, learning situations can be structured in such a way

that they encourage competition, individual work, or cooperation. (Johnson and Johnson, 1991) Science education has tended to favor individual and competitive work over cooperative work. It has also tended to favor rigid structure and discrete, compartmentalized information/skills.

One of the consequences of a concrete sequential style is that it is the teacher who is the authority on a topic because she/he possess the required "information". It becomes the student's job to listen to the teacher, record the information and memorize the 'facts'. A rigidly formatted textbook becomes an extension of the teacher as an "imparter of knowledge". Thus it is the teacher's voice that is important and frequently heard, not the student's voices. Lately, research has been done that indicates that " in everyday and professional life, as well as in the classroom, women often feel unheard even when they believe that they have something important to say" (Belenky, et. al, 1986).
Belenky et al. have grouped women's ways of knowing into five main categories; silence, received knowledge, subjective knowledge, procedural knowledge and constructed knowledge. Experience in the field of science teaching leads me to believe that girls are especially prone to feeling 'unheard' in the science classrooms as they are in other subjects. We rarely seem to be encouraging women to achieve the level of constructed knowledge - an ability to communicate knowledge, create knowledge and view knowing in a contextual way. (Belenky, 1986). Clearly, science teaching must address this if we want to encourage and retain women in the higher level science programs.

IDENTIFICATION OF LEARNING

Perhaps one of the most difficult aspects of education is knowing when learning has taken place. Too often we design tests to check learning and if student success is high then we perceive that learning

has occurred. As previously mentioned, the tests in science courses tend to focus on factual recall or on manipulation of numbers in performing calculations. While teachers find it difficult to decide if learning has occurred it seems that students often do not. In a set of preliminary questionnaires administered to chemistry and biology students between the ages of 15 and 17 it became apparent that the boys generally equated good marks in a course with having a good knowledge of a particular subject. Generally if a male student had average to high marks in the sciences he rated his background knowledge of science as high. He also generally reported good experiences with science in the past. It was interesting to detect that the majority of my female students with average to high grades in science in the past rated their background knowledge of science as "poor". Based on the current literature it would be easy to put this down to a self-concept issue however, involvement with some female students who obtained consistently high grades and seemed extremely self confident led me to question them further.

I am currently conducting a series of case studies and the results to date indicate that female students seem to frequently distinguish between their ability to perform well on a test (to master a particular skill) and their understanding of material. This seemed quite surprising until one of my students , Angie (age 17) , said " just because I can put all the right numbers in the right equation and get a right answer doesn't mean I know why I'm doing it or why I should care". This seemed a fundamental difference, since the male response as Paul put it, was "my marks are real good so I know I know what I'm doing and I like Chemistry". It seems clear that simply the ability to perform a skill or recall a fact is not learning in the eyes of many women. The mark obtained in a course seems less important to many female students than how they perceive their knowledge. This is a surprisingly sophisticated distinction to observe in high school girls. Although many found it difficult to verbalize, almost every female student who told me she didn't

want to take science at University despite her high grades revealed that it was due to her perception of a poor knowledge which would put her at a disadvantage. One girl told me that she always felt like she was "faking it".

Tracking the specific classroom activities that seemed to give female students a sense that they did have a knowledge of a scientific topic became the next stage of study. Informal questioning after daily activities revealed that women tended to feel that learning had occurred when they had a chance to verbalize their positions, thoughts or feelings on a matter. Most of the girls preferred informal discussions, open-ended questions and group work as keys to acquiring knowledge. The central appeal seemed to be speech. When complimented on an astute observation, Jane said " but I didn't even know that I knew it until I said it". There must be an emphasis on speech and interaction in the classroom if we are to show women that they have the ability to acquire knowledge and understanding of science . Clearly intervention is required in current teaching techniques to make women's voices heard in the classroom.

INTERVENTION

Primary intervention is needed in order to open science education to women. In addition to recruiting women teachers (Rosser, 1990) we clearly need to address our predominant teaching methods. We must begin to hear what women have to say about science and this requires us to relinquish traditional teaching techniques. We need to stop teaching discrete skills and encouraging memorization and begin to adopt an "issues" approach to science. Generally, work in the area of an issues approach has revolved around the need to introduce women's issues into our teaching (Rosser. 1986). From my own experience with

high school students, this must be approached with caution and must be done in moderation. Many of the girls I teach are not quite ready to defend their "womanhood" when they are still trying to find out what the role means. Clearly we need to begin introducing women's issues gradually as our individual classes seem ready for such a step. Despite this, the meaning of "issues" can and should be broadened to a consideration of scientific issues of all kinds. If, for women, the key to learning is to vocalize thoughts about science , teachers must carefully structure opportunities for this to happen. Women's ideas must be validated first in small group discussions and eventually in a larger group setting. This requires the structuring of a cooperative, non threatening environment which accepts student knowledge as important. Students must be encouraged to construct their own meaning through discussion of open-ended issues. If there are right and wrong answers, women will frequently not volunteer to speak - as one of my students put it " the teacher just wants me to say what he had in his mind not what I had in mine".

To implement an issues approach, the teacher's role in the classroom must change from disseminator of knowledge to facilitator of personal interaction. This is consistent with current trends in cooperative education and holistic learning. We must show students that arts and science reinforce each other rather than encouraging students to see these as diametric opposites. The ability to communicate ideas is equally important for writers of science as it is for writers of literature. Clearly the process of communication is more important than the final product. A focus on process demands a decrease in the factual content of science courses to allow for more time spent actively involved in learning.

Facilitating communication in the classroom may be done through a variety of structures (and variety is the key). Journals, short stories, newspaper articles, magazines, group projects, drawings, interviews,

round-robin discussions, videos, music, and even poetry have a place in the science classroom. We must begin to change our focus from textbooks to multimedia . In order to inspire such activities while maintaining a science focus, an issues approach should be adopted. There are issues involved in any topic in science for example: energy use in society, health care and drugs, world hunger, poverty, pollution, population explosion, foods and nutrition, industry, science and social development, nuclear power, use of technology to better life, standard of living, and agricultural practice. Within each of these topics there are numerous open-ended and sometimes controversial discussion topics.

In looking at health care we can consider the economics of keeping the elderly alive, the dependence of society on drugs, the issues of genetic screening, coloning, recombinant DNA, euthenasia, ecology, the politics of health care etc. Clearly the use of transactional media such as current newspaper articles, magazines and videos should be used as a spark for discussion. Equally important is the need to allow discussion to progress naturally and to include information and interpretation from all disciplines.

Since women tend to understand through looking at connections we must take pains to draw disciplines together rather than compartmentalize them. Discussing issues necessitates the exploration of the facts of science but there becomes a purpose for the knowledge anchored in experience. The examination of scientist's findings is very important but so is an examination of their drives, motivations, biases, social attitudes to science, and political climate of the day. Nothing exists in isolation, and the students must be allowed to discuss this.

My own experience shows me that all students, especially female students enjoy sharing their views. My female students do not simply enjoy it, they require it in order to feel that learning has occurred. Most importantly, if discussion topics are chosen carefully each student can respond at the level that they are able to. A topic should have equal room for analytical interpretation, social interpretation, personal

interpretation, or emotional interpretation. This validates the position of each student while encouraging her or him to consider other ways of seeing.

CONCLUSION

With the increasing emphasis on science and technology in our society, women are putting themselves at a disadvantage if they opt out of science and math. We need to consider the positives of science, to show students its value and interest - after all, it is the study of life - what could be more relevant? There are increasingly frequent references to health, ecology and environment in the popular media. It requires, not just scientific knowledge but critical thinking skills to examine the accuracy and implications of many of the articles and reports in the media today. Unless we show women that they have the ability to address this kind of material effectively, women will remain disempowered. Belenky reveals that when women are "recipients but not sources of knowledge" confusion and lack of confidence results (1986). We must instill confidence in science. Understanding an increasingly media-based and transaction-based society will become difficult without active involvement in science.

The need to hear women speaking out about science should shape the lesson planning of chemistry, biology and physics teachers alike. Activities must be planned that allow students to speak to each other not just to the teacher. Teacher reeducation is required to help inservice teachers and preservice teachers become experienced with cooperative learning techniques and the selection of materials that encourage discussion. Beyond classroom activities, an issues approach to science has implications for evaluation, teacher-teacher interaction and for curriculum development. Our evaluation techniques must be reflective of our desire to promote speech. Evaluation must be done through a variety of methods including oral reports, group marks,

group skill checklists and personal response writing. Multiple choice exams cannot continue to be the prime evaluation method of science courses. We must see similar changes in curriculum content. The content must be relaxed and teachers must be required to address issues in science and society as part of their programs. Finally, it is necessary that the cooperative learning techniques advocated for student learning be applied to teacher learning also. Teachers must learn to work together to share successes, failures, and materials in such a way as to enhance all teaching and courses. Communication is the central concept for students and teachers. We must make women's voices heard in the classroom and heard in their own hearts and minds.

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A COMPUTER HOLIDAY PROGRAM FOR YEAR 10 GIRLS

G. Joy Teague, Valerie A. Clarke and Marion L. Lyne

Un programme de vacances d'appréciation de l'ordinateur d'une durée d'une semaine a été organisé pour vingt adolescentes de dixième année, âgées de quinze ans. Les deux principaux objectifs de ce programme étaient d'encourager les jeunes filles ne possédant qu'une expérience informatique limitée à utiliser les ordinateurs dans un cadre amical et de coopération, et de leur montrer certains des usages non traditionnels de l'ordinateur. L'objectif à plus long terme était d'encourager ces jeunes filles, et les autres adolescentes auxquelles elles parlent de leur expérience, à entreprendre des études suffisantes sur les applications techniques pour se sentir à l'aise avec les ordinateurs. Ces jeunes filles ont affirmé avoir beaucoup apprécié ce programme et qu'elles seraient ravies de consacrer à nouveau leurs vacances scolaires à un tel programme.

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A COMPUTER HOLIDAY PROGRAM FOR YEAR 10 GIRLS

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ABSTRACT

A one week computer appreciation holiday program was held for twenty Year 10 girls, aged fifteen years. The two major objectives were to encourage girls with little previous experience with computers to use them in a friendly and supportive environment, and to show them some of the non-traditional uses of computers. The longer term objective was to encourage these girls, and others they might talk with about their experiences, to undertake sufficient computing studies to feel comfortable using computers. Feedback from the girls indicated that they thoroughly enjoyed the week, and would be happy to give up future holidays to participate in a similar program.

INTRODUCTION

In the early eighties Montgomery promised much for the future of computing courses in schools, stating that "the emphasis in computer awareness courses is on the knowledge and skills which give an appreciation of capabilities and limitations of computers rather than on technical skills required to program or maintain computer systems" (Montgomery, 1980, p. 1). However by 1984 differential access and usage were already evident and it was recommended that special provision be made for students belonging to four disadvantaged groups (Commonwealth Schools Commission Report 1984), one being girls.

Australian and overseas data show that female participation rates in computing classes tend to decline as both the level of education and the computer science component increase. Data from Victorian Years 11 and 12 enrollments and from Deakin University student enrollment statistics, support this assertion. Table 1 shows percentage enrollments of secondary school students in Year 11 Information Technology units in Victoria in 1991 and Year 12 enrollments for the following year (1992). The Information Technology units are the only computing units available in Year 11, are generally applications based, but can in-

clude some programming, and are taken by all students who want to study computing. In Year 12 the unit content becomes more specialized and gender preferences emerge (Taylor, 1992). These data support the American findings of Lockheed and Frakt (1984) that girls prefer word processing and business applications, whereas boys prefer programming.

The trend continues at tertiary level. Recent Australian statistics suggest that approximately 25% of enrollees in the first year of tertiary computer science courses are girls (Kay, 1990). Table 2 contains enrollment percentages in the B.Sc. computing program at Deakin University in 1992. The first year undergraduate figures correspond closely to those of the Year 12 Computer Science unit, and show a steady decline in female enrollments over successive years.

TABLE 1
Victorian secondary school Year 11 (1991) and Year 12 (1992) enrollments

	Females	Males
Y11 Info. Tech.	52.5	47.5
Y12 social issues	67	33
Y12 applications	56	44
Y12 computer science	26	74

TABLE 2
1992 Deakin University B.Sc. enrollments

	Females	Males
B.Sc. Yr. 1	28	72
B.Sc. Yr. 2	20	80
B.Sc. Yr. 3	16	84
B.Sc. Yr. 4	10	90

The influence of boys in a classroom, and the perceptions girls have of their own ability, and of computing as a possible career all act as deterrents to girls choosing to study computer science. The impact of the gender structure of the school was demonstrated by Clarke (1985) who found that 86% of primary school boys and 52% of girls who had been learning Logo in a coeducational school were likely to view computing as liked more by boys than did girls. Only 12% of girls in an all girls school, all of them in grade 1, thought that boys liked computers more than girls. At first-year university level Clarke and Chambers (1989) found that, although the performance expectations of female students in a compulsory first-year computing and statistics course were lower than those of the male students, there were no significant gender differences in the final results. Teague and Clarke (1991) reported

that the perceptions of computing careers held by tertiary students focused on programming and activities using a keyboard and involved little or no interaction with others, whereas women working in the field described their jobs as varied, people-oriented, and involving relatively little time working alone at the computer.

RUNNING A COMPUTER APPRECIATION HOLIDAY PROGRAM - WHY?

The evidence suggests that girls and women are not perceiving computer science as an attractive option, and are choosing to limit their study of computing to courses utilizing computer packages. Jobs leading from these studies are most likely to be in the occupations traditionally dominated by women, such as data entry, secretarial and office support. The units that lead to higher profile, higher paying jobs remain primarily the province of males at both secondary school and university levels. The challenge is to encourage girls to study more computing and to widen their perceptions of suitable careers. The holiday program was developed as one method of enabling girls to gain hands-on experience with computers, and of showing them some of the less common uses of computers. By providing a supportive environment, with plenty of female role models, it was hoped that the girls would leave the program with more positive feelings about computers and about their ability to use them.

WHO

The holiday program was organized specifically for girls in Year 10, the year in which they are deciding which subjects they will study for their final two years of schooling. As one objective was to encourage girls to study more computing, the target group was girls who currently were displaying little interest in computers but had the ability to study computing. School principals were contacted, the program and its objectives were explained, and they were asked if their school would be interested in sending two girls; two as it was thought that the girls would be more likely to attend if they could come with a friend. In all but one case the principals expressed interest. The principal of this school declined to send any students on the grounds that all girls who wanted to choose computing had ample opportunity to do so in his school. Feedback from another teacher at that school later indicated that there was only one girl in the computer science class - an indication that girls need not only opportunity but also encouragement to study computing.

WHERE, WHEN AND HOW MUCH

The program was conducted at Deakin University for three days and Morongo Girls' College, a private secondary girls' school, for the remaining two days. The University environment permitted the use of electronic mail, a large computer network, and demonstrations of computer applications. The school environment allowed the girls to use computers and software that are suited to their age group but generally are not available in government secondary schools. The second week of the mid-winter vacation was chosen for the program as the weather during this period was unlikely to entice girls away to other activities. A $25 charge was imposed to ensure that they had some motivation for attending.

COMPUTING BACKGROUND

A questionnaire completed by the girls before attending the camp asked about their previous experience. The results, summarized in Table 3, showed that all girls had at least some experience with computer games and most girls had had word processing and graphics experience, although the latter might indicate confusion between studying graphics as a

TABLE 3
Previous experience

	None	Some	Considerable	Extensive
Games	-	2	7	9
Word processing	2	2	12	2
Graphics	5	10	3	0
Logo	8	5	3	2
Databases	9	5	4	0
Spreadsheets	11	1	4	1
Desktop Publishing	12	6	-	-
Lego-Logo	14	4	-	-
Programming	14	3	1	-
Music	16	1	-	1

subject at school and using a graphics package. In the other areas typically taught at schools, around half of the girls had had at least some experience with Logo, databases and spreadsheets. The areas where less than a quarter of the girls claimed any experience were Lego-Logo, programming (they apparently didn't realize that Logo was programming), and music.

THE PROGRAM

The following activities were considered for inclusion in the program:

- introductions using electronic 'talk'
- explanations and demonstrations of applications of computers:
  - video editing,
  - library applications,
  - release of student results via telephone and voice response,
  - Computer Center tour
- a video describing various computing occupations
- electronic mail, both to a penpal for the week, and to a woman working in computing
- computer music
- scientific applications of computers, for example, connected to exercise equipment
- Lego-Logo
- encyclopedic and career information using CD-ROM
- desktop publishing
- graphics
- games
- databases, spreadsheets, graphics, word processing and the transfer of data between them
- programming
- Valiant Roma (floor turtle)

It was decided not to include programming, as learning to program, even at a very rudimentary level, needed more time than was available. If the girls did not have sufficient time to complete a program the experience would be negative rather than positive. All other activities were included in the program.

RUNNING THE PROGRAM

Planning and organization of the program was the responsibility of the three female authors; an academic computer scientist, an academic psychologist, and a secondary school computing teacher. In order to provide the girls with the opportunity to work in a positive, supportive environment, access to assistance was readily available. A number of volunteer female undergraduates worked with the girls at Deakin University. At Morongo Girls' College volunteer Year 12 Information Technology students provided tutorial assistance with desktop publishing. The discussions between the participants and older students about senior secondary schooling and life at university, were perhaps as important as any of the "computing" which took place. In addition, a number of university and school staff gave freely of their time to assist with a variety of specialized activities.

The program ran from nine until three each day, with two morning sessions and one afternoon session. Although a full program was planned before the week commenced, the interests of the girls and the availability of equipment, required some modifications.

HIGHLIGHTS AND LOWLIGHTS

The highlight of the week for the girls was using electronic mail. They each wrote to a student of a similar age attending a summer camp in North America, and to a woman working in computing. The student helpers ensured that the problems of working in a UNIX environment and using the vi editor were negligible when all that a student needed to do to get assistance was to raise her hand. Many girls requested an additional address to which they could write, and several of them particularly wanted to write to boys.

Of the activities presented at Morongo the Works for Windows applications best captured and held the girls' attention. The network and windows environment was new to all of them and more than half had not previously used IBM compatibles.

Throughout the week various problems were encountered, as might be expected when relying on complex computer systems. These problems were dealt with quietly and without fuss. It was considered to be important that the girls should see that problems do occur

with computers, but that they need not cause serious impact on one's activities.

PROGRAM EVALUATION

At the end of the week the girls were given a short questionnaire, which asked simply (and anonymously):
What would you keep next time?
What would you leave out next time?
What would you add next time?
Any other comments?

The responses are summarized in Table 4. Note that, because the questions were open-ended and without prompts, the girls could respond with as many or as few of the activities as they wished for each of the questions and therefore the responses do not sum to 20.

The responses were overwhelmingly enthusiastic about electronic mail and electronic talk. They all thought mail should be kept, several mentioned electronic talk as well, and several suggested that more time should be included for these activities in future. Hands-on activities such as desktop publishing and Lego-Logo were popular, but some students recommended omitting them in future, particularly Lego-Logo which had not been

TABLE 4
Program evaluation

	Next time		
Activity	Keep	Omit	Add
Email	18	-	4
Desktop publishing	9	-	2
Electronic talk	5	-	2
Various games	5	-	5
Music	4	4	-
Video	2	1	-
Writing to professional women	2	-	-
Lego-logo	1	5	-
Application - demos.	-	2	-
Voice response	2	-	-
Video editing	1	-	-
Library	-	6	-
Computer Center	-	3	-
Applications - hands-on			
CD-ROM	1	-	-
Scientific	1	-	-
Graphics	2	-	-
Databases	-	5	-
Spreadsheets	-	-	2
Programming	-	-	3
Nothing	-	3	3
Use of Apple Macs	-	-	1
Miscellaneous	-	-	2

well supervised. Among the suggestions for future activities were other hands-on activities such as programming, database and spreadsheet applications. Several of the demonstrations of computer applications received positive responses, how-ever this area also received the greatest number of negative comments. Music received equal numbers of positive and negative responses. In future everyone will be given a brief introduction to music, then will be offered the choice of more music or another activity.

The girls' overall low level of interest in the Logo, CD-ROM, physiology and sound/music activities was surprising, particularly given the interesting nature of the latter two activities. Hattie and Fitzgerald (1987) suggest that Logo achievement is related to previous computer experience, high scores in mathematics, reasoning and spatial abilities. Perhaps this is a possible explanation for the small group of girls who consistently displayed an active interest in each and every activity available, whilst others were more difficult to motivate. If we are to further our aim of exposing girls to a broader range of computer applications we need to present them in a stimulating and relevant manner. Although all students responded very positively to the "communication" activities, consideration will be given to using a theme to link each of the activities to emphasize their relevance.

CONCLUSION

The extremely positive responses of the girls to the week's activities was evidence of the program's success in the short term. The variety of activities, the friendly, supportive environment, the flexibility that permitted changes to the planned program and the overwhelming success of electronic mail were each identifiable contributors to this success. Further evidence of success was the suggestion put by many of these Year 10 girls that the program should be run for Year 11 girls next year. The trial program this year provided the organizers with a better understanding of the time requirements and of teenage interests. A bigger and better program is being planned for 1993.

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THE EFFECT OF HAVING WOMEN INSTRUCTORS AS ROLE MODELS ON PERCEPTIONS OF PERFORMANCE IN CHEMISTRY

Dr. Shadia A. Tel

Nous étudions ici les impacts d'avoir recours à des instructrices, en tant que modèles à imiter, pour établir les perceptions que l'on se fait des performances dans le domaine de la chimie. Pour ce faire, quatre-vingt-quatre étudiantes et étudiants (37 femmes et 47 hommes) de deuxième année se spécialisant en chimie à la Yarmouk University, en Jordanie, ont participé à l'étude. L'étude comportait un questionnaire, que l'on a distribué à toutes les étudiantes et à tous les étudiants de deuxième année du programme de chimie au début du semestre du printemps de l'année 1991/1992. Les variables suivantes ont été couvertes : sexe des étudiantes et étudiants, sexe de l'instructrice ou instructeur et perception des performances dans le domaine de la chimie. La dernière variable comprenait : complexité du programme, compréhension des étudiantes et étudiants de l'instructrice ou instructeur, performances individuelles par rapport aux performances des camarades de classe et état de préparation au cours.

J'ai délibérément choisi des étudiantes et étudiants qui possédaient approximativement les mêmes antécédents en mathématiques. Les résultats du test MANOVA, puis du test ANOVA, ont révélé un certain effet de modèle à imiter en chimie. Les instructrices encouragent les étudiantes à percevoir la chimie comme un sujet simple, à les comprendre la plupart du temps et à faire mieux que leurs camarades de classe. De leurs côtés, les instructeurs encouragent les étudiants à percevoir la chimie comme étant un sujet simple, à les comprendre la plupart du temps et à faire mieux que leurs camarades de classe. (On a remarqué que les professeurs de chimie féminins avaient plus d'impact que les professeurs masculins.) Ainsi, la présence d'une instructrice en tant que modèle à imiter est cruciale à la perception des performances dans les domaines traditionnellement dominés par les hommes.

The Effect of Having Women Instructors as Role Models on Perceptions of Performance in Chemistry

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ABSTRACT

This study aimed at studing the effect of having women instructors as role models on perceptions of performance in chemistry. To fulfill this, eighty-four (37 women and 47 men) second year students majoring in chemistry at Yarmouk Universty in Jordan, participated in the study. The study was condcted by distribting a questionnaire to all second year chemistry students at the beginning of spring semester 1991/1992 . The following vriables were covered :
sex of students, sex of instructor, and perception of performance in chemistry. The later variable included :
difficulty of the course, the degree to which students understood the instructor, student's performance relative to classmates, and perparedness for the course.

It was deliberately attempted to select only students with about the same mathematics background. Results of MANOVA followed by ANOVA revealed a role model effect in chemistry. Female instructors encourage women students to perceive chemisty as easy, to understand the instructor most of the time, and to perform better than their classmateds. On the contrary , male instructors encourage male students to perceive chemisty as easy, to understand the instructor most of the time, and to perfom better than their classmates. (Moreover, the role model effects for female chemistry instructors were found stronger than those for male instructors). Hence the presence of a female role model is crucial to the perception of performance in traditionally mal areas.

The Effect of Having Women Instructors as Role Models on Perceptions of Performance in Chemistry

During the past few decades, a considerable amount of research has investigated sex differences in performance in science. Research documented large sex differences in achievement in science (Col, 1979; Fennema, 1982). Moreover, research, reported poorer attitudes of girls toward science, less interest in scientific careers, and less comprehension of science. (Chivers, 1984; Becker, 1981).

Maria Mitchell revealed a crucial barrier to women in science; namely, sex-role stereotype of men as analytical, rigorous, and logical which suggests that men are suited to science. On the contrary, sex-role stereotype of women as artistic, delicate, and emotional suggests that women are not suited to science. However, sex-role stereotyping, is a societal factor which affects the role as well as the status of women in science (Kahle, 1984). Accordingly, it is anticipated that if women is brought to science, this stereotype will diminish. Thus, equity between men and women will be achieved, with regard to perceptions of performance in science.

The present investigation aims at testing the following hypothesis: Having women intsructors in chemistry, as role models, improves the perception of performance of students in chemistry. Although there is some evidence (see Becker, 1981) that men as well as women instructors encourage boys more than girls in science, the presence of women as role model is crucial to the success of college women in chemistry, which is used to be a male area of study. Hence, makes women feel that success in chemistry is both legitimate and possible.

METHOD

Sample

The participants were 84 (37 women and 47 men) second year students majoring in chemistry at Yarmouk University, Irbid, Jordan, ranging in age between 17 and 20 years with a mean of 18.3 years.

Data Collection

This study was conducted by distributing a quetionnaire to all second year chemistry, students at Yarmouk University, Ibrid, Jordan at the beginning of spring semester of 1991/1992. The questionnairs covered the following variables: Sex of student, sex of instructor, mathematics courses studied at university level and grades on these courses, science courses studied, and perceptions of performance in chemistry. The latter variable (students' perception of their performance in chemistry) was assessed by anessing the degree of difficulty of the course, the degree to which the student understood the instructor, the student's performance relative to classmates, and preparedeness for the course.

After the completion of data collection, the author found it necessary to control for mathematics background, since previous studies (e.g., Sells, 1980) identified this factor as a critical filter that screens out women from science and engineering majors. In this study, therefore, it was deliberately attempted to control this factor by selecting only students with about the same mathematics background. All of the participants had about the same mathematics background

RESULTS

To investigate the effects of having had women as role models on perceptions of performance in chemistry, women and men students in this study were divided according to whether their chemistry instructor had been male as opposed to being female. Results of multivariate tests of significance

(see table 1), concerning student perceptions of their performance in chemistry, indicated that the main effect of the instructor sex (F= 4.13) was significant at = 0.05. Moreover, there was a significant (instructor sex X student sex) interaction effects at = 0.01 for chemistry (F=5.42). However, there was no significant effect for the student sex (F < 2) on the perception of performance in chemistry.

University F-tests were then conducted on the four meansures of perceptions of performance; namely, difficulty of course, performance relative to classmates, percentage of time understood instructor, and preparedness for course.

Results (see table 2) revealed significant main effect of the instructor sex on: The difficulty of course (F= 4.69, < 0.05), the performance relative to classmates (F= 7.56, < 0.01), the percentage of time understood instructor (F= 7.65, < 0.01), and the preparedness for course (F= 4.5, p< 0.05). 77.35% of chemistry students with female instructors, as compared to only 26.6% of chemistry students with male instructors claimed to perform better than their classmates. Moreover, 77.35% of chemistry students with male instructors, as compared to only 35.45% of chemistry students with male instructors, felt the class was hard. Furthermore, 27.35% of chemistry students with male instructors, as compared to 35.45% of chemistry students with female instructors claimed to understand the instructor most of the time. The last indicator, the preparedness for course, revealed that 60.7% of chemistry students with female instructors are better prepared for the course, as compared to only 42.85% chemistry students with male instructors.

Results (table 2) also indicated that main effect of the students sex on variables of perceptions of performance in chemistry was not significant at < 0.05 (F was less than 3.1 in all cases). However, there were three significant

instructor sex X student sex interaction effect on difficulty of course (F= 8.9, < 0.01), percentage of time understood instructor (F= 5.5, < 0.05), and performance relative to classmates (F= 8.6, < 0.01). 23.8% of women, as compared to 47.1% of men, in chemsitry with female instructors felt the class was hard; whereas, 83.3% of women, as compared to 71.4% of men, in chemistry with male instructors felt the class was hard. Moreover, 23.8% of women, as compared to 29.4% of men, in chemistry with male instructors believed themselves as performing better than their classmates; whereas, 71.4% of men, as compared to 83.3% of women, in chemistry with female instructors believed themselves as perfoming better than their classmates. The final indicator, the percentage of time understood instructor, shouwed that 47.1% of men, as compared to only 23.8% of men, in chemistry with female instructors claimed to understand the instructor most of the time; whereas, only 11.8% of women, as compared to 42.9% of men, in chemistry with male instructors claimed to understand the instructor most of the time.

DISCUSSION

The analyses of the data indicated that when mathematics background was controlled, instructor sex had effects on perception of performance in chemistry. Female instructors, more than male instructors, encourage students to feel chemistry classes as easy, claim better performance in chemistry relative to classmates, claim better understanding of the chemistry instructor, and be better prepared for chemistry course.

Moreover, the analyses revealed role model effects in chemistry. Female chemistry instructors encourage women students to perceive chemistry as easy and to understand the instructor most of the time. Also, female chemistry instructors encourage women students to perform better than their classmates. On the contrary, male chemistry instructors encourage men students to perceive chemistry as easy and to understand the instructor most of the time. Also, male chemistry

instructors encourage men students to perform better than their classmates. It follows that the role model hypothesis was confirmed with regard to chemistry . Moreover, for chemistry the role model effects for female instructors were stronger than those for male instructors. Hence, the presence of a female role model is crucial to the perception of performance of women in a tradionlly male area (chemistry). In other words,the presence of a female role modle makes college women perceive that succes in chemistry is both possible and ligitimate.

Clearly, the findings of the present investigation are by no means final due to the limitation of the small sampl size. However, this study could well provide a stimulus for further research of the fundamental issue regarding the effect of samesex role model on the perception of performance in other science areas.

Table (1)
Summary of
Multivariate Tests of Significance Concerning
Student Perceptions of Performance in Chemistry

Test Name: Wilks

Effect Course	Chemistry
Student Sex	
Exact F	1.629
Instructor	
Exact F	4.1273*
Instructor Sex X Student Sex	
Exact F	5.4211**

* P < .05
** P < .01

Table (2)
Univariate F-tests Concerning Student
Perceptions of Performance in Chemistry

Variable Effect	Effect: Instructor F ratio	Effect: Student Sex F ratio	Instructor Sex X Student Sex F ratio
Difficulty of Course	4.68609*	1.24536	8.92696**
Performance Relative			
to Classmates	7.56041**	0.09283	8.62588**
Percentage of Time			
Understood Instructor	7.65166**	3.0555	5.49701*
Preparedness for			
Course	4.500*	0.18056	2.99015

* P < 0.05
** P < 0.01

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GIRLS AND SCIENCE EDUCATION IN SIERRA LEONE

Joan O. Amarteifio

L'étude de recherche met l'accent sur l'inscription des filles aux cours de sciences de six écoles de filles et mixtes. Leurs performances à l'examen pour le certificat de la West African School ont été étudiées.

Des données ont été recueillies auprès du ministère de l'Éducation et dans les dossiers des écoles. Le personnel enseignant et les étudiantes et étudiants ont également été interrogés.

Les résultats ont révélé que deux à trois fois plus de garçons que de filles s'inscrivaient à des cours de sciences. Cette différence était due, en partie, à la croyance erronée que les cours de sciences conviennent davantage aux garçons qu'aux filles.

Dans l'ensemble, les garçons ont obtenu de meilleurs résultats que les filles. En outre, les performances moyennes des garçons et des filles dans les cours de sciences étaient bas comparativement aux cours artistiques et commerciaux. Ceci était dû, en grande partie, à des installations de laboratoire inadéquates et à un manque de professeures et professeurs de sciences qualifiés.

En examinant les résultats de cette étude, on a découvert que les filles des écoles de filles avaient mieux réussi que les filles des écoles mixtes à l'examen du niveau ordinaire du certificat de la West African School.

Quatre-vingt pour cent des filles interrogées estimaient que leurs possibilités d'emploi dans le domaine commercial étaient bien meilleures que dans les professions scientifiques. Toutes les filles qui n'étudiaient pas les sciences ont indiqué que les mathématiques et la physique étaient des matières difficiles à comprendre.

Les interventions visant à accroître le nombre de filles dans les programmes de sciences devraient comprendre une amélioration des normes de l'enseignement des mathématiques aux paliers primaire et secondaire et de meilleures conditions de travail pour les professeures et professeurs de sciences.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

GIRLS AND SCIENCE EDUCATION IN SIERRA LEONE

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ABSTRACT

The research study focused on the enrolment of girls in science courses in six single sex and coeducational schools respectively. Their performances in the West African School Certificate examination was researched.

Data were collected from the Ministry of Education and the schools records. Teachers and pupils were also interviewed.

The results indicated that the number of boys enrolled in science courses was two to three times more than those of girls. one of the reasons for this disparity is the erroneous belief that science courses are more suitable for boys than for girls.

In general the boys performed better than the girls. Furthermore the general performance by both sexes in the science subjects is low compared with the arts and commercial subjects. This is due to the inadequate laboratory facilities and shortage of qualified science teachers.

From the results it can be concluded that girls in single sex schools performed better than those in mixed sex schools at the West African School Certificate ordinary level examination.

Eighty percent of the girls interviewed were of the view that the job prospects in the commercial field were much better than those in the scientific professions. All of those not studying science found mathematics and physics difficult to understand.

Interventions to increase the number of girls studying science should include; the improvement of the standard of teaching of mathematics at primary and secondary levels; and better conditions of service for science teachers.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

INTRODUCTION

Sierra Leone is a former British colony and the system of education is similar to that of the British. The number of years spent at the primary, secondary and university level are 6,5/7 and 4/3 years respectively.

Science is taught at the primary level and one of the objectives of the course is,"to enable the child to develop an understanding of his physical environment beginning with the home environment and widening into community and national environment". (Ministry of Education, 1984). On the average an hour a week is spent on studying science.

At the secondary level an integrated science course is taught from forms 1 - 3 and a decision to major in the science subjects is made at the end of the academic year in form 3.
After studying the basic sciences for two years (in form 4 and 5) pupils take the West African School Certificate Ordinary Level Examination (WASC 'O' level). It is the enrolment and performance of these girls in 6 single sex and 6 coeducational schools that was researched.

After successfully passing the WASC 'O' level examination pupils spend two years studying the basic sciences at the end of which they take the WASC Advanced level examination. After graduating all of these students attend universities locally or abroad.

The objective of this study were:

- to establish the low enrolment of girls in basic science subjects in single-sexed as well as coeducational schools.

- to evaluate the performance of girls in single-sex and coeducational schools.

- to identify the factors which militate against the enrolment and performance of girls studying science at schools.

- to suggest interventions which would improve the enrolment and performance of girls in secondary schools.

Method

Data were collected from the Ministry of Education and the records of six single sex and six coeducational schools in Sierra Leone; at least one school from each province or area. (There are four provinces; Eastern, Northern, Southern province and the Western area. The capital is situated in the Western area). The school laboratories were also visited and facilities examined. The pupils and teachers were also interviewed.

RESULTS

Over a period (1983/84 to 1987/88) of 5 years the percentage of the girls studying science subjects in single sex schools was consistently higher. On the average 24.6% and for mixed sex schools; 11.8% (see Table 2).

Also from the results girls attending single sex schools performed better than those in coeducational schools at the WAEC ordinary level examination. The mean success rate in single sex schools was 44.1% and that in coeducational schools was 7.0% (see Table 1).

From the data it can be concluded that at the ordinary level more girls study science at single sex school than in mixed sex schools. Also their general performance is better than those in coeducational schools.

The study showed that the most popular subjects in secondary schools are the commercial, arts and home economics subjects and the least popular are the science subjects. Similar observations were made by Amara (1985). It was also observed that at 'O' level, the single sex schools laboratories were better equipped than those of the coeducational schools. All of the schools visited were inadequately equipped. This is mainly due to the economic crisis faced by Sierra Leone.

Also the laboratories in single sex schools were not only better equipped but those schools had more qualified teachers than the coeducational schools. However it must be pointed out that generally there is a shortage of qualified science teachers. This is a problem faced by many African countries including Botswana (Mpuchane S, 1988).

It was also found out that in most of the coeducational schools, laboratory technicians teach science at the lower levels (forms 1-3). At higher levels part-time teachers were employed; university lecturers also teach on part-time basis. The teaching of science subjects in forms 1 to 3 by technicians also had its negative effects on the performances of the students.

The schools' records also manifested a high staff turnover particularly amongst male teachers. Some teachers give up teaching to go into the private sector. For example a female biology teacher gave up teaching to go into dressmaking business full time; she said it was financially more rewarding.

The pupils mentioned that they were not studying science because they found it difficult particularly mathematics and physics. The shortage of teachers and equipment were also reasons for not studying science. Those who were studying science said they found it challenging and rewarding and all of them had to attend private remedial classes (for which their parents were paying high fees) to make up for the shortage of teachers.

Another reason why the single sex school produced better results is that the best students attended those schools. Entry to secondary school is by a Selective Entrance Examination. The mediocre and weak students end up in the coeducational schools.

Eighty percent of the girls interviewed preferred the commercial subjects because the job prospects were better. Similar observations were made in India (1993, Mahajan S.B.). One student studying home economics stated that with the economic recession she was planning to be self-employed and with home economics background she could start a catering or dressmaking business.

CONCLUSION AND RECOMMENDATION

The research study showed that at the General Certificate of Education ordinary level science examination girls in single sex schools performed better than those in coeducational schools. Some of the reasons for this observation have been outlined. Also the enrolment of girls in science subjects in single sex schools is higher than those for girls in coeducational schools in Sierra Leone.

It was also observed that the overall performances of boys in science subjects was better than those of girls.

In order to increase the enrolment and performances of girls in science subjects the following recommendations could be made:

- more time should be spent teaching science at the primary school level.

- the conditions of service for teachers in general and science teachers in particular should be improved upon.

- the laboratory facilities should be improved upon and more emphasis should be put on practical work.

- efforts should be made to improve the standard of maths teaching at both primary and secondary school level.

- there should be more in-service training for science teachers with the aim of improving the quality of science teaching.

- and finally there should be North - South and South - South links between schools. Exchange programmes for science teachers and pupils should be encouraged.

Table 1: Performance of Girls in 6 Single Sex and 6 Coeducational Schools 1983/84-1987/88

	Single Sex School	Coeducational School
Year	%age Successful	%age Successful
1983/84	50.5	10.2
1984/85	41.1	8.5
1985/86	40.4	6.0
1986/87	37.3	3.4
1987/88	51.4	7.2
Mean	44.1	7.0

Table 2: Enrolment of Girls in Science Subjects in 6 Single Sex and 6 Coeducational Schools 1983/84-1987/88

	Single Sex Schools	Coeducational Schools
Year	%age girls studying Science Subjects	%age girls studying Science Subjects
1983/84	14.7	10.0
1984/85	29.4	13.2
1985/86	26.0	16.0
1986/87	17.6	4.1
1987/88	35.2	15.6
Mean	24.6	11.8

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FACTORS RELATED TO GIRLS' ATTITUDE TOWARDS CAREER INTEREST IN SCIENCE IN BENUE STATE OF NIGERIA

Dr. Tortiv Ato

Une échelle d'attitudes à 8 échelons, «Career Interest in Science», a été appliquée à un échantillon stratifié au hasard d'étudiantes du palier secondaire (N = 438) de l'État de Benue, au Nigéria. Les variables école-étudiante, ainsi que quatre sources d'information scientifique, ont été étudiées.

La régression multiple, la solution multiple, l'estimation de la variance groupée et le coefficient de corrélation produit-moment de Pearson ont été utilisés pour analyser les données utilisant le SPSS.

Les résultats justifient de demander aux professeures et professeurs de sciences qu'elles et ils déploient des efforts délibérés en vue, avant tout, d'encourager les filles et de les sensibiliser aux possibilités de carrière dans les sciences. De plus, la publication de livres scientifiques à contenu axé sur les carrières pourrait s'avérer utile.

Dans l'ensemble, les résultats indiquent que les plus jeunes filles, après les adolescentes et les filles éduquées dans des écoles de filles, font preuve d'attitudes plus positives dans l'échelle des attitudes.

Les résultats montrent une influence égale de la socialisation et de la maturation. Les filles plus âgées, moins intéressées par les carrières scientifiques, pourraient vraisemblablement penser au mariage. Par conséquent, il est essentiel de les décourager de se marier tôt, afin de pouvoir les recruter et les retenir dans le secteur des sciences, de génie et de la technologie.

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FACTORS RELATED TO GIRLS' ATTITUDES TOWARDS CAREER INTEREST IN SCIENCE IN BENUE STATE OF NIGERIA

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ABSTRACT

An 8-itemed attitude scale, 'Career Interest in Science', was applied to a stratified random sample of Secondary School girls (N = 438) in Benue State of Nigeria. School and student variables together with four chosen sources of scientific information were studied.

Multiple regression, stepwise solution, pooled variance estimate t, and Pearson product moment correlation were employed in the analysis of data using the SPSS.

The results warrant a call for science teachers to make deliberate efforts to specifically encourage girls and make them more aware of career opportunities in Science. Also, the production of science books with career oriented content could prove useful.

Generally, the results indicate that the younger girls, third from girls and girls educated in single-sex schools show more favourable attitudes towards 'Career Interest in Science'.

The results equally suggest the influence of socialization and maturation. Older girls who have less interest in science oriented careers could likely be thinking about marriage. There is need therefore to disabuse their minds about early marriage in order to help their recruitment and retention in science, engineering and technology.

INTRODUCTION

It is a simple fact that to undertake a career in science involves having the necessary qualifications. those who fail to choose science in their school days therefore, would not hope to take a career in it. Early choice option of Secondary School as is the case in England and Nigeria is difficult to categorize as militating against science

options. Delays in the choice may or may not lead to science choice and it is likely that those who happen to choose science as a result of the early choice could change their minds (Ormerod and duckworth, 1975).

Ability in science, science choice and career choice are closely related. Many factors are related to career choice(Opoku-Agyeman, 1977). In a Nigerian situation, 'socio-economic status' is not so strong a factor, for many successful scientists are products of subsistence farmers. School preparation, achievement in science courses and contact with scientists are especially important in the Nigerian situation. To be added to this list is awareness of career opportunities in science. This present study established from female students some factors relating to their attitudes towards 'Career Interest in Science'.

APPROACH

An 8-itemed attitude scale, 'Career Interest in Science' was applied to a stratified random sample of Secondary School girls (N = 438) in Benue State of Nigeria. To prevent mental sets being fixed, the items were randomised with those on scales measuring attitudes towards four sources of scientific information and administered as a single instrument made up of 48 attitude items.

The scale 'Career Interest in Science' developed and validated has a split-half reliability of 0.84 (Ato and Wilkinson 1982). The four scales on the sources of scientific information had the following split-half reliability coefficients: Attitudes towards scientists 0.74, Attitudes to science teachers 0.78, Attitudes to science books 0.84 and Attitudes to science practical work 0.81 (Ato and Wilkinson, 1986). Usage made of scientific equipment was

assessed using a developed schedule (Ato and Wilkinson, 1986) with a test-retest reliability of 0.78 for students.

Scchool variables studied include form, school type, school ownership and school location. The students' variables studied include sex, age and usage of science equipment .The stratified random sample obtained was based upon the above variables (N = 438). This comprised 166 girls from Government Schools, 272 girls from voluntary Agency Schools, 283 girls from urban schools and 155 from rural schools. It also included 280 girls from single-sex schools and 158 from co-educational ones; 263 from third form and 175 from fourth form. 232 formed the high usage group and 206, the low usage group. 302 were under 16 years and 136 above 16 years.

ANALYSIS AND RESULTS

To see which 'student' and 'school' variables contributed most to the prediction of the girls' attitudes to 'Career Interest in Science' stepwise regression, analysis were undertaken. These particular analysis selected the most persimonious group among all these independent variables that would explain the variance of students' scores on the scale. The results obtained are given in table I.

In addition, the contribution of the four sources of scientific information was also established. The results are given in Table II.

In addition the Pearson product-moment correlation was computed using the SPSS to ascertain the relationship of the girls' attitudes towards 'Career Interest in Science' and the four sources of scientific information. The results obtained are given in Table III.

Table I

Multiple regression, stepwise solution for the relative importance of predictors of girls' attitudes towards Career Interest in Science.

Independent Variable	Multiple R	R^2	R^2 Change	b
Form	0.198	0.039	0.039	-1.955
School type	0.249	0.062	0.023	-1.518
Age	0.253	0.064	0.002	-0.541
Location	0.255	0.065	0.001	-0.430
Usage	0.255	0.065	0.000	0.101
(Constant)				38.620

Table II

Multiple regression - stepwise solution to the relative importance of the sources of scientific information as predictors of girls' Career Interest in Science.

Independent variable	Multiple R	R^2	R^2 Change	b
Books	.750	.562	.562	.477
Scientists	.759	.576	.014	.137
Practicals	.765	.586	.009	.149
Teachers	.767	.588	.003	.068
(Constant)				4.235

Using t, analysis (Pooled Variance Estimate) the relationship of 'student' and 'school' variables and girls' attitudes towards 'Career Interest in Science' was established. The SPSS sub-programme 'T-Test' was employed and the results

DISCUSSION

The suggestion that (Johnstone and Sharp, 1970) effort made by employers to encourage students towards scientific careers should be concentrated at the younger age group is supported by the result of the study. The younger girls show significantly more favourable attitudes towards career interest in science than the older ones (see table IV).

The younger girls, third from girls and girls educated in single-sex schools show more favourable attitudes. The results question the early findings by Pieris, (1949) that Urban girls are more interested in science activities than rural girls. This is reflected in their attitudes towards 'Career Interest in Science'.

The results suggest the influence of socialization and maturation. Older girls show less interest in science careers and could likely be thinking about marriage (McRobbie, 1978). There is need therefore to disabuse their minds about early marriage.

The prediction of the girls' attitudes towards career interest in science, as reflected in the regression equation, indicates that all the independent variables studied are found to be contributring significantly to the variance. The magnitude of the individual contribution of the independent variables however varies (see table I) as it is reflected in the order of entry in the regression equation, stepwise solution, with 'form' entering first. The same picture holds true for the four sources of scientific information. 'Science books' is entered first followed by 'scientists' Science Practical Work' and lastly

obtained are given in Table IV.

Table III

Pearson product-moment correlation of girls' attitudes to 'Career Interest in Science' and the four sources scientific information.

Sources of Scientific Information	Pearson r	Significance
Scientist	.41	P<.01
Science Teacher	.40	P<.01
Practical Work	.62	P<.01
Science Books	.75	P<.01

Table IV

The significance of 'school' and 'student' variables in girls' attitudes towards 'Career Interest in Science'

Independent Variable	Group	Score	SD	SE	t - Value	Signi-ficance
Age	12 - 16	29.17	5.53	0.32	2.7	P<.01
	17 - 19	27.66	5.07	0.44		
Form	3rd	29.56	5.15	0.32	4.1	P<.01
	4th	27.45	5.58	0.42		
Ownership	Government	28.90	5.67	0.44	0.6	NS
	voluntary agency	28.60	5.27	0.32		
Location	Urban	29.01	5.27	0.31	1.6	NS
	Rural	28.17	5.66	0.45		
Type	Single-sex	29.37	5.59	0.34	3.4	P<.01
	co-educational	29.53	4.94	0.39		
Usage	High	29.53	4.90	0.52	1.2	NS
	Low	28.63	5.67	0.44		

to science.

There is some sense in maintaining girls' schools although schools presently established in Benue State of Nigeria are mostly co-educational and this would seem to accentuate the girls' situation (Ormerod, 1981).

In conclusion, it could be observed that the improvement of girls' attitudes towards 'Career Interest in Science ' is the first step in the process of their recruitment and retention in science, engineering and technology. Shrigley (1978) noted that if we can assume that attitudes are not innate, but learned we must also assume that a positive attitude towards science can be taught.

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'Science Teachers' (Table II). All the four sources of scientific information also correlated significantly with career interest in science (see Table III).

The result show that there is a strong association between career interest in science and positive attitudes to 'science books'. Foveve:, 'Science Teacher' is found to contribute the least to the variance explained by the four sources of scientific information. The result possibly implies that science tea~hers have little impact on the students' attitudes to a scientific carrer. Previous findings show that interest in science and possibly science careers are independent of the teacher (Vargo, 1976).

In Nigeria, where trained career guidance officers are lacking, it is expected that teachers will have a strong impact on students' career interest in science. The result however adds to the fasct that a science teacher has little influence (Lambert, 1944). There is need therefore for science teachers to make deliberate efforts to not only encourage students but also to make them more aware of career opportunities in science (Dillon and James, 1977). It has been observed that (Raskin, 1962), lectures about women scientists are more effective in improving girls attitudes towards scientific careers than talk about career opportunities for women in science.

These results seem to suggest that at present Nigerian students in the Benue State, particularly girls, are more dependent on what they obtain from science books. The production of science books with career oriented content could therefore prove useful. Taylor. (1979) noted that se:: bias in science textbook material develops poor sttitudes to science and is a possible cause of girls' indeffirence

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SEX GRADIENTS AND SUCCESS OF SCHOOL GIRLS IN SCIENCE AND TECHNOLOGY IN THE THIRD WORLD

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Certaines barrières culturelles, qui freinent les femmes dans leurs réalisations et qui sont responsables de l'inaptitude de ces dernières en sciences et en technologie, se perpétuent. Les modèles à imiter, les attitudes à l'égard des sciences et la persévérance semblent distinguer les femmes des hommes. On examine l'hypothèse comme quoi les filles considèrent les sciences comme quelque chose de masculin, craignent les sciences et les évitent dans le cadre de leurs études. Le stéréotype sexuel et l'accomplissement des étudiantes et étudiants ont été examinés en tant que variables indépendantes. On a découvert que les modèles à imiter et les accomplissements des étudiantes et étudiants n'étaient nullement reliés entre eux, mais que les accomplissements supérieurs des filles en sciences contredisaient les conclusions des études effectuées dans les pays occidentaux. On considérait que les filles qui étudiaient les sciences et la technologie étaient plutôt masculines. Sur l'échelle des attitudes, les filles trouvent que les sciences sont des activités plaisantes et bénéfiques. L'étude du facteur persévérance, indexé dans cette étude, recherche le sexisme dans le phénomène. La partie productive de la persévérance est un facteur encourageant les accomplissements des filles. Il fournit aux filles l'énergie nécessaire pour surmonter les obstacles culturels et même pour utiliser ces obstacles à leur avantage.

" SEX GRADIENTS AND SUCCESS OF SCHOOL GIRLS IN SCIENCE AND TECHNOLOGY IN THE THIRD WORLD "

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ABSTRACT

Certain cultural barriers persist that negate women's success and account for their unsuitability to science and technology. The role models, attitudes towards science and perseverance seem to distinguish women from men. The hypothesis that girls sense science as of masculine image, are scared of science and avoid it as a course of study was examined. The sex-stereotype and students achievement were examined as independent variables. The role models and achievements of students were by no means found correlated, but superior achievements of girls in science contradicted the findings of the studies done in the western world. The girls who studied science and technology subjects were found masculine on personal traits. On attitude scale girls find science open pleasing and beneficial activity. The perseverance counts, indexed in this study seeks sexism in the phenomenon. The productive part of perseverance is functional promoter of girls achievements. It provides girls an energy to defuse barriers of cultural stereotype and utilize even the barriers to their significant gains.

Cultural barriers persist to negate women success in science and technology and account for women's unsuitability to some science courses. These barriers leave the women of India down, insecure and segregated from the men in general. "Our children and our students are the participants in a complex process that equips one sex with mathematics, science and technical skills, indispensible to functioning in the adult world while it fails to encourage the same development in the female sex". (Skolnick, Langbort and Day, 1987). This fact directly causes immense loss to both the sexes and more so to the nation.

The pervasive disparity in the access to educational

opportunities between sexes in the third world is a matter of great concern. Availability of facilities does not by itself ensure female participation. There are other factors. May be, the expectations and perceptions of effects of schooling on them : in terms of procuring employment, acquiring a suitable husband, and their future roles as wives and mothers.

The policy frame of the constitution of India speaks of equality of men and women in regard to various categories and humanitarian issues such as employment or appointment to office or adoption of means of livelihood, etc. But, decades after having adopted the constitution, women in India remain helpless congruence of illiteracy and victims of covert discrimination unable to utilize constitutional provisions relating to their parity with men. However, women decent to accord this truth and charge the existing set up as instrumental in causing discriminations to them. The social and traditional norms established for generations are too strong to permit any radical change in the existing social structure of women. Consequently women continue to remain an exploited and backward section of the Indian society. Similarly, the 3rd world societies the world over, are riddled with gender based inequalities, even when they constitutionally claim to be discrimination free.

In the developing countries, women are considered as only beneficiaries of development rather than active participants of the process. Because of the slow moving economy of developing countries, men tend to safeguard their own interests first. Keller (1985) on relevant data established how the paradigm of science bears witness to male control and power. This is perhaps one intuitive possible explanation for why young girls do not exhibit interest in science and technology. But, it is

not the most likely explanation. The more probable explanation is their gender identity. A genderless identity is inconceivable. Gender is interwoven into social roles. It regulates relations among and between girls and boys. Empirical studies from all over the world show that culturally derived gender mechanisms operate in the choice and also success in science and technological courses.

The Role Models in Relation to Their Achievements in Science

The role endurances, the cultural inhibitions,the unfavourable or indifferent attitude of society towards girls' education, the male superiority and its dominance, the social neglect, negative self concept of girls towards science and technology, all imbue male superiority and negative self image of girls towards science and technology.

The hypothesis that girls sense science as of masculine image are scared of science and avoid its option for study was examined by creating high and low sex stereotype groups. The findings in this regard were set to contradict Kelly's assertion that culture, attitude of people and their education shape the preferences of girls and boys for science. Against this the findings of this study reveal that sex-stereotype neither boosts students choice for science nor in their achievements. A summary of our findings is given below :

(i) The proportional counts of either girls or boys who prefer or avoid science is evenly distributed. It is a complex and difficult proposition to arrive at a conclusion that sex stereotyping is related to girls preference for science.

(ii) The Chi-square analysis also retains independence of stereotyping against girls option for science and technologies.

Paradoxical the phenomenon may seem when the mean achievement scores of boys and girls were tested for significance once between high and low stereotypes and secondly between boys and girls keeping stereotyping constant. The findings in this

regard were well founded and interesting. The high and low stereotypes did not significantly differ, i.e. sex stereotyping and students achievements in science are independent variables. Science is neutral and unrelated to any sex image. But on second analysis when in low stereotyping girls achieve significantly higher than boys. The girls seem to adopt a more non-traditional and less feminine perception of science that results in the superior achievement of girls in science, so sex rather than role model is a potent instrument of girls achievement in science.

Kelly & Barbara Smail in their study the missing-half, Girls and Science (1981) also pleaded 'femininity and masculinity did not appear as opposites'. However, their effects in some ways were quite distinct. These results for Indian situations are not worrying. The girls need not limit their academic horizons on the basis of their sex stereotype. Their perception of science as of male domain is a myth (at least in developing countries) and presumably, not for them. The children (in Kelly's study) who accepted sex stereotypes showed slightly less interest than other children in the branches of science traditionally associated with other sex (Kelly, 1987).

Smither and others (1991), using single bipolar item to measure masculinity, explored sex differences in respect of the masculine self-image or orientation towards science.

"The basic assumption of the study was that the achievement of girls in science or technology is a function of girls' stereotype roles in society. Sex stereotyping represents a feeling in girls that they are girls and these fears induce them to stick to the role models of girls in society. These roles impinge upon girls' freedom of choices owing to a long tradition of backwardness of the third-world societies" (Archana 90).

The feminine perception and self-image of subjects appears to frustrate the realization of positive correlation between feminine self-image of girls and their achievement in science and technology in India. It is certainly a mark of approval and

realization of masculine image of science. Even otherwise; it could not be established by the findings of this study that the girls who studied science and technology subjects were masculine on personal traits; still the statistical measures on analysis supported the claim that masculine or feminine self image associated with boys or girls was independent of boys' or girls' achievement in science and technology.

The researches done in the past have examined the continuance of girls in science courses and the findings justified their retention on the three different bases : cultural, educational, and attitudinal (Kelly, 1989). Bouyer, Bybee & Sund (1986) realized that boys in schools are valued for thinking logically and independently with self confidence and with appropriate degree of risk taking; while the girls are valued for their emotional expressiveness, sensitivity to others dependency and subjective thinking. These sex differences do certainly affect the examination results. Thus, immutably the differences are because of the sex stereotype. The male orientation of science generally keeps the girls away from science. This fear is culturally induced. Even the parents find science repulsive for their daughters.

An Attitudinal Study of Girls in Science and Technology

Erickson & Erickson (1987) in their review identified a gradient in the cultural backwardness of third-world countries. It also divulged a thesis that children during adolescence try to attest their gender identity and self image. The stereotyped role models, therefore, not only seem to determine students' gender identity in science and technology classes, but also their success in examinations. This hypothesis has frequently been advanced by Kelly (1987). But, presently, the studies conducted by Peter Fensham in Thailand; Pinchas Tamir and

others in 3rd world countries, claim that the superior achievement of girls in science and technology is invariably true for all grades. But, the findings of several studies conducted in the advanced countries are at variance with these findings and declaim the superiority of girls to vindicate that the results of researches on this problem are yet inconclusive.

The author while constructing a tool to measure attitudes of school students towards science identified four major areas : science for self and society, anxiety against science, achievement and motivation, choice of science as career, and image of science. From the elicited list of 49 statements, 35 were finally selected for the attitude scale. The reaction from subjects (200) were then gathered on a five-point scale, affixed before these statements.

The girls in general reported that science was useful both for students self and society as a whole. It viewed science alone could solve the major problems afflicting the country such as; those pertaining to agriculture, energy warfare over population, conservation, pollution, etc. 'In the field of anxiety' the girls reported : Working with science would not be a fun. It made the girls stupid while responding to the items concerning choice of science as career. Majority, hesitated rather amazed to sense, if they could be selected as - Engineers, Doctors, Lawyers, Administrators, as no achievement motivation hangs with them. Naturally, therefore, their achievements be poor. The highly sex stereotypes were found more apt to learn science precisely physical sciences. It reveals their determination and highly positive attitude towards science as against boys who displayed a poor attitudes. A large proportion of girls was found to show high degree of masculinity or sex-type. That seems to be reflected in girls superior achievement in sciences. But most of these girls who like boys, find science more suitable for boys. Then why is girls' achievement superior ? It seems that attitude of girls is a part of general constellation of idea of science, i.e., science is open, beneficial and a pleasing activity. It may also be attributable to factors like perseverance.

Perseverance Correlates of Achievement in Science

The initial strategy of the study was to establish the hypothesis that perseverance operant was not significantly related with the achievement of boys or girls. But, the statistical analysis correlated construct, and further, the girls perseverance score was higher than that of boys. Here, the dominance of perseverance as girls sex role seems to count for girls edge over boys.

Taking that the novelty of role functions of girls lay in their persistence and perseverance and that it would prove a significant predictor of the achievement of girls in science has been procured and its phenomenal evidence established. To explore the genesis of perseverance, the researcher developed and standardised a tool on perseverance; analysed it objectively. The cluster analysis of students perseverance scores generated a conclave of sight significant factors :

1) Employing goal directed efforts objectively.
2) Commitment to duty.
3) Recognising persistence as a socially desirable value.
4) Conceived areas of interest.
5) Firm determination for achievement.
6) Persistence against counter influences.
7) Self confidence.
8) Aspiring to achieve high and be recognized.

The dubious nature of the construct identified in the comparative study of boys and girls as achievers and perseverants seem to waver the acceptance of hypothesis that achievement and perseverance were highly correlated. It appears polarised into two subconstructs. One segregates the boys and girls on their functional roles and the other boxes them into similar roles.

Sl No	Perceived superiority of girls.	No perceptible difference
1.	Commitment to studies.	1.Employing goal directed efforts objectively.
2.	Recognizing persistence as socially desirable value.	2.Conceiving it as area of interest.

Contd.on 8.

3. Persistence against counter influence.	3. Firm determination.
4. Self confidence.	4. Aspiring to achieve high and be recognized.

The study records the perceptions of elites group a gentry of Lawyers, Administrators, Professors, Journalists, etc. They perceive girls superiority over boys on the first cluster and obtain no significant difference on the second cluster. The first of the cluster that expounds superiority of girls seems to augur : their committed habitual toil and their cultural endurance, is a reflection of how the girls in India or in the countries of 3rd world are being reared. It is an index of zeal that inducts them to employ their selves whole heartedly to all that is desirable. Their 'persistence' is a socially impregnated value. This attitude develops a potential fecundity in girls to diffuse the barriers and utilize them to significant gains.

Perseverance, thus indexed seem to be divided in two substratums. One that seeks to sense sexism in the phenomenon while the other indicts perseverance as independent of sex roles. The components that sensed sexism seem to be more culturally loaded in favour of role-models of girls in Indian society. The findings of this study generate two factions of reactants of elites on perseverance behaviours. One is 'Productive' and the other one, 'Inert' in the up-bringing of 'perseverance' in girls. The productive is a functional promoter of girls' success. The role models impose inhibitions upon girls activities and frees the boys to act in a way they like.

Kelly reported the components as male self and female self which directly impinge upon the sex role behaviours as distractors. But, the girls in India develop an energy to defuse the cultural barriers and utilize even the barriers to their significant gains. But, the construction as a whole is not edible in easing out better achievement results. Only four of the components, commitment, recognizing persistence as a socially desirable value, persistence against the counter influence and

self confidence do favour girls and have been weighted heavily against boys. The Productive Perseverance components evince the superiority of girls over boys. The teaching and learning science has, however, been the fecundity or prerogative of boys. Women's entry in this area may be seen as an attempt to cross the barriers, even otherwise the women have been found more successful than men on the counts of perseverance that compensates the gradient.

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ADOLESCENT GIRLS' VIEWS ON SCIENCE: A MALTESE STUDY

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L'étude décrite dans ce document a été effectuée en République de Malte, dans une école secondaire régionale pour filles. Elle consiste en une enquête ethnographique de la culture d'écolières vue de leur propre perspective. Le document met l'accent sur les idées et opinions que se font ces filles, ce qu'elles en pensent des sciences, pourquoi elles estiment que le domaine des sciences s'adresse davantage aux garçons qu'aux filles, et ce qui les intéressent dans les sciences.

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ADOLESCENT GIRLS' VIEWS ON SCIENCE: A MALTESE STUDY

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ABSTRACT

The study presented in this paper was carried out in Malta in an area secondary school for girls. It is an ethnographic investigation of the adolescent schoolgirl culture from the girls' own perspective. The paper focuses on the girls' ideas and opinions on science, what they think about science, why they think science is more appropriate for boys than for girls and what interests them in science.

INTRODUCTION

Girls view science, particularly physical science as masculine (Klein, 1989). Despite the fact that girls view science as predominantly masculine, they are still interested in and want to learn more about science. The problem exists not in trying to find out why girls and boys have different science interests or how to make what is considered to be "masculine" science more appealing to girls but rather to identify what interests girls in science and to build on these interests. As Whyte (1988) states "women

have a particular contribution to make to science by virtue

of their being women" (p. 8).

Girls are more interested in the biological sciences than in the physical sciences. They are interested in subject matter related to health, nutrition and the human body especially when the subject matter is placed in a context related to daily life or to society. Girls are also excited by science lessons which emphasize practical "hands-on" experiences (Peltz, 1990).

I had been a teacher in a Maltese area secondary school, teaching girls aged between eleven and thirteen. I wanted to know more about what interested the girls in science and what they themselves really wanted to learn. The main purpose of this study was therefore to explore the students' own views, ideas and opinions about the way in which they were learning science.

METHODOLOGY

In the study, I wanted the students to express their own ideas and opinions because as Davies (1982) states, "Children have been written about from many perspectives, and for a multitude of purposes but rarely have they been asked to speak for themselves" (p. 1). Because I wanted the study to "lay stress on the study of everyday life and on the actors' own interpretations and definitions of the situation" (Delamont, 1978, p. 60), I decided to use an

ethnographic style of research.

I carried out the study in the school where I had previously been a teacher. Like Pollard (1985), I decided that "I could positively use the shared experience and rapport which I had built up previously to the advantage of the research" (p.227). I worked with five students who all came from working class families and who are described by the Headmistress as "students who do not shine in their work". Starting in September, I met these girls for about an hour every day. The meetings were in the form of informal group interviews. We would sit down around one of the laboratory benches and talk and I would interject at intervals with open-ended questions. Throughout the interviews I established a relationship of trust and understanding with the students. Within the "we-relationship" (Davies, 1982), which developed with my students, they actively sought to help me see things their way. They felt that they could be open with me and for them, "...You were like a friend to us...more than a friend...you were like a sister, not like a teacher..."

I recorded all the conversations with the girls on a small tape-recorder, and later transcribed the tape. In the process of transcribing I started to form patterns in my mind about what was happening. I divided the

transcriptions according to the themes which were emerging, for example a section relating to science interests, one to teachers, the school and so on. I then went through each section until a clear picture of what was happening started to build up in my mind and I started to write a narrative of what the girls had told me. I went in with a prepared plan of action and certain ideas which I thought would emerge from my study. The developing relationship changed the way in which I listened to what they had to say and changed the lenses through which I read the data.

GIRLS' VIEWS ABOUT SCIENCE

When I asked the students to write down the first thing which came to their mind when they heard the word science, the following words emerged: animals, chemicals, personal care of body, growing up, nature, feeding of animals, what things are, environment, laboratory, experiments, our life, medicine, how things in the world work, discovery about things, our body, what things have inside. These descriptions involve only the biological and chemical aspects of science. There is no mention of anything associated with physics. When asked how they thought that science could be useful in their lives, the girls talk only about the uses of science inside the home:

> ...to know how to bring up your baby and take care

of your children...help you to know what you are eating and drinking and maintain a balanced diet...and if you know about evaporation it will help you in the kitchen because if you are boiling the pasta, you know that steam comes out when you take the lid off...Also if you are cleaning the house and you find a leaf on the window, then you will know all about it...

I thought that perhaps this reflected their views of science as a masculine endeavour and when asked to draw a scientist, invariably the girls reflected the work of Fort and Varney (1989), and drew a scientist who was male, wore glasses, stood close to a laboratory bench, held instruments, wore a lab coat and had a beard or a moustache. When asked why they drew all male scientists the girls gave the stereotypic answer that "men are more suitable as scientists...they have nothing better than girls but I see a scientist being more a man."

Laura: ...when we see programmes on television, for example, about earth...they always show men...they never show a woman...

Anna: ...a man...a woman doesn't occur...

Laura: ...but it's because we don't see too many

of them...and those who are with them...the women scientists...seem to be more to help the scientists than anything else...instead of doing the things themselves...

Sarah: ...they pass them things...

Despite this view of science, the students are very keen on learning science. The first science topic of interest was "Growing Up". The girls describe "growing up, how the body works, about babies and how they are born", as being the topics which interest them most in science. Other topics of interest include talking about AIDS, smoking, drugs, cancer, artificial insemination and test tube babies. They also enjoyed discussing topics such as evolution, recycling and the state of the environment.

The girls are interested in a wide variety of topics, yet they are also excited by simple scientific exploration such as looking under a microscope. The students themselves ask to talk about AIDS. At first Anna, appeared to be interested, then all of a sudden she pointed to the microscope and said "that's what really interests me." We continued to discuss AIDS and in the middle of the conversation, Sarah interrupts "can we look under the microscope like yesterday... I really had fun."

Since the girls seemed to be excited by a variety of

things in science I began to question, what it was that made science so enjoyable or so hard. The students themselves came up with an answer. As Anna puts it, whether a science lesson is interesting or not "depends on the way in which the teacher teaches." Maria adds:

> If a topic is boring and the teacher explains it in a boring way, then it will remain boring ...but if the teacher explains in an interesting way, then you read about it and the teacher gives you many details and you start to like it...it's boring when the teacher repeats the same thing over and over again...

IMPLICATIONS

My first premise had been to lay the blame for unmotivated students on the science curriculum, on the fact that girls viewed science as being more relevant for boys than for girls, but even here the girls taught me another lesson. I could not fight the system, I could not be idealistic and believe that I could change the whole science curriculum, student and teacher attitudes but I could do something in my own classroom. I could take the topics in the present curriculum and with a little bit of imagination and creativity present them in such a way that they would be exciting, fun and interesting to the students. I could relate some things to their everyday life experiences and

let them enjoy the pure discovery of scientific facts in others. Most of all I had to take their ideas into consideration. If they were more interested in certain topics I should allow them to grow scientifically through what interested them and not try to make an engineer out of a girl who was only interested in biology. I realized that my ideas and concerns as an adult might not be their ideas and concerns as adolescents, and I had to listen to what they had to say before embarking on any kind of activity.

The girls in the study show that they are interested in a variety of topics in science. It does not matter to them whether they are talking about something which is useful in their daily lives, or whether they are just mixing chemicals. The important thing for them is the way in which the topic is presented, that it is presented in an interesting way which grasps their attention. Also important is that they are involved in what they are doing, that they are active participants in their own learning. This builds a sense of confidence and self-esteem, allowing them to believe in themselves and their own potential. The most effective approach is not to regard girls as a special species of learner in science, but to acknowledge the role of girls' interests, experiences and understanding in the science classroom (Erikson & Erikson, 1984).

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GENDER EFFECTS OF LEARNING CYCLE METHOD ON STUDENT LEARNING IN SEVENTH GRADE LIFE SCIENCE CLASSES

Joseph M. Cumo
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Cette étude compare les effets de deux méthodes d'enseignement de concepts scientifiques sélectionnés, reliés à l'osmose, adaptées pour les élèves de septième année d'écoles de régions rurales de l'Ohio. Deux classes ont testé la méthode du cycle d'apprentissage pour introduire ces sujets dans une séquence exploration/invention/découverte; deux autres classes ont appris par le biais de la méthode traditionnelle information/vérification/pratique; et les classes d'un groupe témoin, qui n'avait pas encore étudié l'osmose, ont été prétestées et posttestées relativement à leurs connaissances du contenu, leurs attitudes à l'égard des sciences, leurs aptitudes de processus et leur raisonnement formel. Les données suggèrent que la méthode du cycle d'apprentissage est supérieure à la méthode traditionnelle pour améliorer les aptitudes de processus, favoriser des attitudes positives à l'égard des sciences et le développement cognitif chez les étudiantes et étudiants de la septième année. Des effets différents, selon le sexe, ont été relevés en ce qui concernait la connaissance du contenu et les attitudes positives à l'égard des sciences.

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GENDER EFFECTS OF LEARNING CYCLE METHOD ON STUDENT LEARNING IN SEVENTH GRADE LIFE SCIENCE CLASSES

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ABSTRACT

This study compared effects of two different methods of teaching selected science concepts related to osmosis to seventh grade students in rural Ohio schools. Two classes experienced the Learning Cycle method (LC) of introducing these topics in an explore/invent/discover sequence; two classes were taught by the Traditional method (T) of inform/verify/practice format; and control group classes that were not yet instructed on osmosis were all pretested and posttested on content knowledge, attitudes toward science, process skills, and formal reasoning. Data suggest that the LC method of instruction is superior to the more prevalent T method for encouraging process skills, positive attitudes toward science, and cognitive development in seventh grade students. Differential effects by gender were noted on gains in content knowledge and in positive attitudes toward science.

INTRODUCTION

Gender-related differences in achievement, in number of kinds of science classes chosen, and in science-related careers chosen have been noted in literature on outcomes of science education, especially over the last twenty years. For example, male students were found to understand scientific processes better than did female students (Levin, Sabar, and Libman, 1991). Girls, in turn, viewed interest and

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Les soumissions - Colloque international GASAT 7, Canada, 1993

study of physical sciences and related technologies as "masculine" traits (Kelly and Smail, 1986 and Levin, Sabar, and Libman, 1991). This attitude toward science seemed to translate into girls' avoidance of science classes and science-related careers (Campbell, 1991; Kelly and Smail, 1986; Maple and Stage, 1991). Some researchers have suggested that valid and important *ways of knowing* (e.g. Belenky et.al. 1986; Gilligan, 1982; Tobias, 1990) have been ignored in traditional teaching. The omissions may contribute to the disinterest and lack of achievement of too many students in science classes.

The question asked in this study was whether the Learning Cycle (**LC**) method of teaching selected concepts would have different outcomes than the Traditional (**T**) method of the teacher providing information, verifying it with a demonstration or a lab activity, and requiring students to demonstrate understanding by answering questions on the topic.

The Learning Cycle (**LC**), according to Karplus and Lawson (1974), incorporates elements of three learning theories: learning by association, learning by discovery, and learning by reasoning. The latter is synonymous with Piaget's ideas on the development of rational thinking. Karplus called basic elements of the learning cycle sequence ***exploration*** (student uses new materials and/or idea with minimal guidance); ***invention*** (teacher defines concept or explains procedure); and ***discovery*** (student finds new applications for the concept or skill). Others have labeled the cycle as ***data gathering, concept introduction,*** and ***concept application*** (Lawson, Abraham, and Renner, 1989). Whatever the terms used, teachers and students do not play the same roles under the **LC** vs. **T** strategy. Principal differences between these methods are outlined in Table I.

TABLE 1.

Comparison of Instructional Methods

LEARNING CYCLE	TRADITIONAL
Exploration	**Introduction**
student-centered	teacher-centered
divergent	convergent
knowledge: unspecified	knowledge: specified
predictable	predictable
student constructed	facts provided
information/idea emphasis	vocabulary emphasis
cooperative learning	individual learning
Invention	**Verification**
teacher-coordinated	teacher-directed
communications:	communications:
student-teacher	teacher-student
student-student	student-teacher
teacher-student	
concepts discovered	concepts verified
textbook is a resource,	textbook is source of
not a limiting factor	and limit to information
Discovery	**Practice**
application oriented	answer oriented
concept is extended to	concept is used to
other situations	answer teacher or
	text questions
further inquiry/experiment	reading text is typical
encourages active	activity
learning	

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

RESEARCH PLAN

Three teachers were selected from three rural Ohio schools of similar size, socioeconomic background, curricula in operation, primary instructional methods, and science education goals. Two of the teachers were provided with instruction, modeling, and practice with the LC method of instruction which was not familiar to them. They were also provided with scripts for teaching the assigned lessons on osmosis in each of their two life science classes in different ways: traditional method (T) in one and learning cycle method (LC) in the other. Classes of a third teacher in a third rural school (where seventh grade students were not studying osmosis at the time) were used as control groups (C) during this quasi-experimental study. The teachers played their assigned roles for four consecutive weeks, providing traditional instruction to designated classes and learning cycle sequences of the same material to another pair of intact classes. Instruction in all six classes was monitored by videotaping and visits by the primary researcher to insure that teaching conditions specified were maintained during the length of the study.

Subjects (N=153) were not randomly assigned to groups, but classes were randomly assigned to treatment. They were chosen from rural schools where

1) there is no university nearby, so students would not have had opportunities to develop extraordinary testing or learning sophistication;
2) schools are within reasonable geographical proximity;
3) traditional instruction (as defined on Table 1.) is the principal method used;
4) life science curriculum and textbooks are the same in each school.

Students were pretested a week before the differential treatments began. Then after four weeks of either learning cycle or traditional life science instruction, students were posttested with the same four instruments to measure their knowledge of the lessons' content, their science process skills demonstrated on

TIPPS II (Burns, Okey, and Wise, 1985), on the Lawson Test of Formal Reasoning, TFR (Lawson, 1978), and on the Science Attitudes Inventory, SAI (Simpson and Oliver, 1985). One month after the first posttest, a remote post- test was administered to measure knowledge retention only. (More detailed information on this content measure and its validity can be obtained from the authors.)

RESULTS

a. Content Knowledge

There was no significant overall difference between the learning cycle (LC) and traditional (T) classes. The treatment methods seem to have been equally effective at delivering content. However, when analyzed by gender, differences appear. Boys in the LC classes outperformed all male and female counterparts on the first pretest. However, girls in LC classes made the greatest gains on the remote posttest.

b. Cognitive Development

No gender differences were noted on results of using the Lawson Test of Formal Reasoning (TFR). However, students in LC classes achieved a significantly higher adjusted mean score than did those in T and C classes. The LC students gave more explanations, more detail in their answers, and more frequent use of item-specific language in their written responses on the TFR.

c. Science Process Skills

The most significant difference between groups was scored on TIPPS-II. The LC classes outperformed the others. There was no significant difference by gender; boys did not out-perform girls on this measure, and both boys and girls apparently benefit from LC classes.

d. Science Attitudes Inventory

Again, the LC classes surpassed the others in making positive gains in attitudes toward science. Although there was no measurable difference between LC boys and girls on this inventory, girls in the LC classes outperformed their counterparts in T and C classes. Data suggests that LC method may have had a beneficial effect on girls in particular.

N.B. Statistical tables on all results are available from the authors.

DISCUSSION

Despite the short duration of treatment, this study is provocative in suggesting that teaching methods (LC vs. T) may have differential outcomes for students not measurable by immediate post-instruction tests of knowledge alone. Adolescents who have opportunities to actively integrate their observations in ways that have personal meaning will be more likely to develop their science process skills than will students who have only traditional school science lessons.

LC procedures provide for student actions on the content at the student's readiness level. Exploration and concept invention phases focus on data gathering and meaning construction, respectively. Given background knowledge, appropriate experiences, and meaningful concept formation, students have a high probability of gaining skills, attitudes, and intrinsic motivation to learn more about science. Because these outcomes are so fundamental to success in science by all adolescents, the learning cycle method should be more widely adopted and supported. "Just the facts" are no longer enough. More active learning puts science in context, develops student thinking skills, and generates greater appreciation for the evidences of human creativity in real science.

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COURSE CHOICE AND GIRLS' VISIONS OF THEIR FUTURES

Linda Eyre

Nous affirmons ici que les idéologies domestiques et les facteurs structurels limitent le choix des filles dans les programmes de mathématiques et de sciences physiques. Ce document est basé sur une étude de questions relatives au sexe dans le choix des programmes de mathématiques et de sciences. Des données ont été recueillies dans le cadre d'entrevues effectuées auprès de plus de 200 étudiantes et étudiants de 12e année, provenant de diverses régions urbaines et rurales de la Colombie-Britannique. Les choix des filles étaient plus souvent liés à leur idée de l'importance d'avoir une carrière et à leurs attentes en matière de relations conjugales et de rôle parental. Les hypothèses relatives à la division de la main-d'oeuvre et aux changements dans les structures sociales doivent être abordées si l'on souhaite prendre au sérieux l'inscription des filles dans les programmes de mathématiques et de sciences.

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COURSE CHOICE AND GIRLS' VISIONS OF THEIR FUTURES

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ABSTRACT

This paper argues that domestic ideologies and structural factors limit girls' course choices in mathematics and the physical sciences. The paper is based on a study of gender issues in student course choice in mathematics and science. Data were collected through interviews with over 200 Grade 12 students (girls and boys) from rural and urban areas of British Columbia. Girls' course choices were tied to their views about the importance of careers for women and their expectations about marital relationships and parenting. Assumptions about division of labour and changes in social structures need to be addressed if girls' enrollment in mathematics and science is to be taken seriously.

INTRODUCTION

In recent years there has been a move away from blaming girls and women for their lack of participation in mathematics and the physical sciences (Rosser, 1990; Willis, 1989; Walkerdine, 1989). Along with knowledge in the curriculum and classroom pedagogy, attention is also being focused on the social context of girls' course choices.

This paper explores how domestic ideology and social structures limit girls' course choices in school mathematics and physical science. The paper is based on a tri-university study of gender issues in student course choice in mathematics

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

and science (Gaskell, McLaren, Oberg & Eyre, 1992). The study was part of the British Columbia Mathematics Assessment, 1991. Data were collected through interviews with approximately 200 Grade 12 students (girls and boys) from 12 schools situated in rural and urban areas of the province. Interviews attempted to find out why students were or were not taking mathematics and physical sciences at Grade 12. The interview questions used to frame this paper deal with girls' expectations about their future lives.

Girls' Visions of Career and Family

Most girls expected to have careers. That many girls chose careers in engineering, architecture, law, medicine, aviation, commerce, and business, as well as more traditional careers in teaching, nursing, and secretarial work, suggests an important change from the past.

Nevertheless, in interviews, many girls talked about the difficulties of combining a career with marriage and children. A few girls said that if they had children they would drop out of the paid labour force:

> If we have children then it doesn't matter what my career is at the time...I have cousins that are looked after by their grandparents and by nannies, and I think it has a detrimental effect. (mathematics/physics student)
>
> Well for females it's harder...you're expected to stay home with the kids and maybe most women feel that there's

> a need to stay home with the kids when they're young. (non-mathematics/physics student)

What is particularly interesting here is that girls enrolled in mathematics and physics, many of whom had non-traditional career expectations, and girls not enrolled in these school subjects were similarly trapped in domestic ideology.

Most girls, however, wanted a career and children. These girls talked about the child-care options available. Some girls spoke optimistically about shared parenting:

> I don't think it would be a problem sharing at all. It shouldn't be and if it was then I don't think he would be the type of person that I would want to marry. (mathematics/physics student)

Other girls said that they would place their children in day care, with neighbours, or with a nanny.

> Well you know it's really hard to have a career and keep a family because you won't be there a lot of times....I won't see my kids a lot. I'll have to employ a nanny. I know a lot of rich successful women who have nannies and they don't see their kids a lot...My career is really important to me. I want my own life. I don't want to depend on him. (mathematics/physics student)

Some girls said that the partner with the lowest income should stay home and care for the children:

> I really don't believe in both parents working...but whoever has the better (income) should keep working or whoever doesn't enjoy their career should stay home with the children. It might work out that if I had my career I would have to leave it and wait till my kids are grown up and start again, or maybe my husband will stay home. (mathematics/physics student)

> Girls are brought up more to that kind of thing and guys don't...we just don't have the knack for it.

And they envisaged themselves as "breadwinners":

> I plan to be very successful. I'll try to leave time for my family and give them a good life....I come from a poor family - I want them to enjoy life. (Would both partners work?) Well for the first while but I want to support them...once I start having kids. I think I'll want her to stay home and let me bring in the bread, bring home the bacon or whatever.

But some boys did agree with women working outside of the home:

> Well when the child is young somebody has to be there and then as soon as it is old enough have it looked after by somebody else....Like I wouldn't want my wife to stay home with them, that's not the way it is anymore.
>
> You could get injured and your wife would have to support you while you recover, or you could be going back to school and she'd have to work.
>
> She could (work part time) because then she can come home and clean the house.

Overall, boys' responses were more traditional than girls.

Discussion

Childcare was very important to girls' views of their futures. Most girls wanted a career and children but did not trust strangers with the care of their children, nor did they expect their partners to do it. Consequently most girls felt they would have to give up their career, at least for a few years, in order to care for the children. In so doing, most

assumed that women had a choice about whether to enter the paid workforce. The girls did not speak about the difficulties of dropping in and out of the labour market, about the possibilities of parenting alone, or of the risks for women who are financially dependent on others. Clearly such discussion needs to be addressed with students.

Girls' views of themselves as primary caregivers may affect their course choices in school and ultimately their career paths. If girls perceive these courses as difficult and sequential, and our study suggests this is so, girls may be reluctant to enrol or continue in science fields because they envisage a future interrupted with childrearing. They may opt for courses which they perceive as easier and therefore more fitted to an interrupted career path. Rather than give girls false hopes, the sensitivity of the science professions to the gendered experiences of women needs to be addressed.

In contrast, boys views of themselves as "breadwinners" might influence their desire to pursue maths and sciences, particularly if they view these subjects as leading to lucrative and secure careers. Given that girls and boys frequently mentioned the notion of men giving women permission

to pursue careers, the influence of men's views on women's career choices is worthy of further consideration.

It would be wrong to assume that the girls passively accepted traditional gender roles. As Jane Gaskell (1992) argues "Students are active participants in the process that produces differential course enrolments" (p. 39). Although some girls in this study were trapped in domestic ideology, others had good reasons for being concerned about their children's futures. In Canada, quality affordable day care remains a dream, many men are reluctant to participate fully in domestic work and child care, and most university programs, businesses and industries do not accommodate the demands of parenting. If we are really serious about girls' futures, domestic ideology and social structures require attention.

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Like most girls who responded in this way, this student avoided naming the person most likely to stay home if "lowest income" was the criteria for selection.

But most girls who wanted a career and children said that they would put their careers "on hold" when their children were young, and return to the workforce either full-time or part-time at a later date:

> My personal goal is to go through university...not being tied down, not being married, not having children until I've at least established myself. Then I think I'd like to settle down and start a family....I'd probably do something similar to what my mother did - stay home for the first few years at least while the child is small, at least until they're going to school and try some sort of part-time job, so at least you are there when the kids come home from school. (mathematics/physics student)

> Having kids would definitely interfere with my career. I figure you should have kids or a career but not both.... Like maybe when the kids get older and they're at school all day long then you can pursue a career, but not when they're little and home all day....I'll just put my career on hold for a couple of years and then go back. Like I feel that it is really important that the mother be the one home that's home. Like my mom she got really sick when I was seven...so I've never had a mother figure and I don't want my kids to grow up like that. (non-mathematics and physics student)

Again, there were surprising similarities in responses between girls who were taking and not taking mathematics and physics.

Many girls assumed that they would have a choice about whether to stay at home or enter the paid workforce:

> No man's gonna hold me back...but after my first child, like if I don't want to work any more and I want to come back and stay home, if that's my choice then that's fine by me you know. (mathematics/physics student)

> I want a career to fall back on. Then I plan to take a few years off to raise my family...then I'll go back to work....I expect him to support us and...help out when I'm not there. (non-mathematics/physics student)

Despite evidence to the contrary, these girls were clearly forthright and optimistic about the future.

But, some of the girls who held traditional views about their future lives were also aware of the contradictions:

> I may decide like my mother did not to go back to work. But you know I've watched her and I've seen in some ways she really wishes she was back working and in other ways she's glad she didn't. (mathematics student)

> It would be a bit of a problem if you got into a real career...and then all of a sudden you had to stop and have a family....It would depend on the job, but that's the thing that's a little confusing...you can't really figure out if you should do that or not. But it may be something that you find more interesting than something else you know where you can't really take a break from that well. (mathematics/physics student)

These girls were acutely aware of the conflict in preparing for a career and then abandoning it for life as a homemaker.

As well, it would be wrong to assume that all girls passively accepted traditional roles. Many had reasons for putting their careers "on hold" whilst parenting:

> It would really be nice if you could get a man who'd cook, clean, you know, do all the laundry, but

> realistically he probably won't. (mathematics/physics student)
>
> I can't see any man staying home to look after kids...they don't worry enough. He could look after the child once or twice but I wouldn't want to leave him with the child all week long. I believe the child needs its mother. Men can't raise children as good as a woman can. That's the one thing we do much better than they do. They don't watch enough. (non-mathematics/physics student)

For these girls, career choices were limited because they believed that men would not or could not do domestic work. Clearly, domestic ideology and social structure place constraints on girls' career choices.

Boys' Visions of Career and Family

Unlike girls, boys did not raise the topic of marriage and children when asked about their future lives. When questioned most boys said that their careers would not be affected by marriage and children:

> No. Why would it be affected? No. I don't think so.
>
> If I get a wife and kids, there won't be any hampering of my career.
>
> I'm going to do what I want to do. No-one is going to change that.

Boys assumed that women would be the primary caregivers:

> I guess the wife would take care of it, or else I'd have to get a babysitter or something else, or day care or something like that.

A KID'S COMPUTER CAMP AS A SOCIAL MICROCOSM FOR THE STUDY OF FEMALE AVOIDANCE OF TECHNOLOGICAL TRAINING

Sharon Frantz and Catherine Warren

Cette étude de recherche examine les observations d'une personne ayant participé à un camp d'été sur l'informatique organisé pour les adolescentes et adolescents par une université canadienne. Fondée sur une plus vaste étude des professions féminines et technologiques, cette étude avait pour but d'établir les raisons pour lesquelles les femmes s'intéressent moins que les hommes à la formation et à l'enseignement des sciences et de la technologie, même lorsqu'on les y encourage autant que les hommes. L'étude du camp d'informatique présente un nouveau «texte»; un texte d'avant-plan qui permet d'explorer les hypothèses et buts sous-jacents contribuant au concept d'autorité et aux «façons de savoir» masculines dans l'enseignement des sciences. Ce document traite des tendances relevées pour les pratiques pédagogiques féministes dans l'enseignement des sciences et de la technologie.

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A KID'S COMPUTER CAMP AS A SOCIAL MICROCOSM FOR THE STUDY OF FEMALE AVOIDANCE OF TECHNOLOGICAL TRAINING

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ABSTRACT

This research study analyzes a participant observation study of a summer computer camp for young people held at a Canadian university. As part of a larger study of Women & Technological Occupations, its purpose was to obtain insights into the complexities of the observation that fewer females than males seem interested in technological and scientific training and education even when apparently similar encouragement is given to both sexes. The study of the computer camp presents a new "text"; a foreground text which allows one to explore the underlying assumptions and aims which serve male authority and male 'ways of knowing' in a science educational pedagogy. Implications for feminist pedagogical practices in the teaching of science and technology are presented.

INTRODUCTION

Jonathan Culler (1982) notes that the experience of the female reader as she begins to interpret and to understand a text ironically presupposes an understanding that she has not been "reading text" as a woman, but that her interpretive context has been guided by male interest. He explores the presumed gender neutrality of 'text' and 'knowing' to reveal that male interests often co-opt feminine texts and interpretations. The female reader finds herself complicit in the ways in which her own understandings are tied to the dominant 'ways of knowing'.

We are interested in texts and/or interpretations of text which challenge the way that human beings understand themselves. Literary critique can create a lens through which the experiences of marginalized people (such as women) might find expression. The concept of 'text' can be

extended metaphorically to represent a textual system: the social or institutional principles which govern the dominant paradigmatic orientation of curricular thought.

The dominant discourse in education and in science education in particular has been read as gender neutral. Curricular and instructional theories in mainstream academia, graduate classes included, claim to represent education as a gender neutral category and experience (Wittrock 1986). Mainstream science educational writing, even when pushing the limits of modern paradigms of thought, still marginalizes women's experience in the sciences and technologies.

In this article, we are interested in presenting a new 'text': a foreground text for research on education within a computer camp. In the act of reading and understanding, 'we/womens' interpretations of such a text and subtext, we can explore the assumptions and aims which serve to preserve male authority and male 'ways of knowing' in educational pedagogy and computer science. (The use of the pronouns 'we/women' does not represent homogeniety of opinion, but rather is a metaphor for reclaiming women's experience by noting a difference from men's experience and by insisting on this difference).

In exploring research 'narratives' in science and technical education, as researchers we wish to inquire into the nature of knowledge claims in this field. In teaching science and technology, what constitutes the 'text'? Academically, which 'texts' are most commonly researched and what underlying assumptions do they contain? Are the research 'stories' observed by researchers really extensions of male 'texts'? Which interpretative frameworks do our research 'narratives' represent? Where is the female voice, her authenticity, and her authority?

Ellen Dubois and her colleagues (1987) suggest that if the questions guiding research are designed so that only male activities can provide the answers, then it is difficult if not impossible to obtain an authentic feminine interpretative framework. By challenging biased assumptions, new questions and answers arise; in turn, these create the conditions for a radical restructuring of research frameworks so that feminine inquiry is not pushed to the margins of academic inquiry.

If we are to explore alternatives to methods, assumptions and goals which have served to preserve men's ways of 'knowing' and hence male authority, then we must engage in a 'reading

of the text' through a feminist lens. We can insist upon the importance of women as interpreters of text: women whose feminist lens can penetrate the 'false consciousness' created by the male order which can often cloud the lens of both male and female researchers.

THE RESEARCH DESIGN:

For the last decade, Canada has seen a proliferation of summer computer camps at schools and universities across the country. Their purpose is to instruct students aged 7 – 16 in beginning and advanced levels of computing science and its applications. From the start of such "Kid's Computer Camps" it has been observed that while females may enrol in similar numbers to the males in the beginning courses, they seldom return for the advanced courses in the same numbers, if at all (Collis, 1987).

This research study analyses a participant observation study which the researchers made with respect to a number of sections of a summer computer camp for young people held at a Canadian university during the summer of 1990. Initially the purpose of the study was to obtain insights and understandings into the complexities of the observation that fewer females than males seem interested in technological and scientific training and education, even when apparently similar encouragement is given to both sexes. As such, it was part of a larger study of Women and Technological Occupations undertaken by the principal investigator.

As the computer camp study proceeded it became apparent that epistemological interests emerged which revealed underlying patriarchal intentions and assumptions within the research questions and within the study. Male and female students appeared to experience computer training differently. In order to uncover what knowledge was legitimized by the teachers and to uncover tacit interests of authority and control in the classroom, and the implication of these for both boys and girls, a feminist critical framework was developed and used.

The researchers/observers visited 16 different sections of the camp during a six-week period. The number of times each section was visited varied but no section was visited less than twice and some sections were visited up to six times. Typically students would start in a lecture classroom and after a one hour period of teaching, would move to a computer lab where two

more hours of intensive hands-on computer training proceeded. Computing sections took place in IBM, Zenith and Mac labs.

An enthographic description of classroom interactions and theme analyses became a major part of the methodological orientation of the study however, for space purposes, will not be included here. Themes for analysis and discussion were obtained form the following sources: transcribed open-ended interviews between the researchers and each teacher; observations of each teacher's classroom lessons and transcribed notes or scripts of those sessions; all curricular handouts; and a journal or log of the reflections of the researchers.

EPISTEMOLOGY AND GENDERED CURRICULUM:

Although philosophical debates, beginning with Kuhn (1970) have challenged positivism, it conventionally is still incorporated into mainstream science-educational theoretical research and understandings. Traditional textual understandings are still the underlying epistemological frameworks observed in the context of teaching computing science. The theme analyses indicate that two instructors, Eric and Werner (pseudonyms), appeal to fact/value dichotomies in their explanations of PASCAL and BASIC. The computer, in the teaching context, is viewed as an "objective" force differentiated from and superior to the social context: it is programmed with scientific knowledge, a monolithic power which is seen as a force to "control" and "manipulate" the computer. This positivist orientation orients students to a social view of the world of computers as one in which an authoritive, patriarchal, controlling, manipulative, and ultimate power heads a hierarchy of knowledge. The theme analyses indicated that for those low in social power, such as females, the attainment of such power themselves is seen as beyond their reach or not appropriate for their gender role.

The observational scripts suggested that the language of the computer, the preferred language of interaction between the instructors and students, and the design of the computer itself were all dominated by positivist assumptions. One of the theme analyses demonstrated that the pedagogical style of instructors, such as Werner, is imbued with an underlying subtext which is positivist, along with assumptions that such a positivist subtext is the only appropriate one.

An Undifferentiated Curriculum:

The undifferentiated curriculum is designed with the assumption that girls come with the same life experiences and the same interests as boys. It also is assumed that even to the extent that boys and girls encounter similar life events, that social forces will affect them the same way and hence they will derive comparable meanings from those events. Both assumptions are problematic from a feminist critique.

The computer camp curricula were designed to teach students introductory programming languages such as PASCAL and BASIC. The assignments were meant to motivate interest in the computer. The computer language, the content, and the presentation was mathematical and normative in nature, however the social content of the assignments appealed to boys. For example, one class utilized a "brewing" experiment. Graphics and amination were generally found to appeal to boys' previous socialization experiences: cars, turtles, architectural space designs, war games, brewery experiments (for older students), and mathematical number games. One assignment, a mystery song, appealed to girls in the class, but some of the boys quickly lost interest. One instructor who taught graphics and animation to 7–12 year olds noted:

> ...boys like space concepts (Star Trek) and Teenage Mutant Ninja turtles. They explore the voice capacity of the computer and are interested in sounds that have an impact-bomb explosions; air space travel sound. They also enjoy war games...girls draw trees, animals and talk a lot.

Computer software as well as the operational language of computer instruction was often remarkably aggressive, authoritarian and patriarchal in its design and hence off-putting for those low in the power spectrum or for those who do not endorse the particular set of values associated with dominance. Warren (1986) in an earlier study, observed the rules posted by the teacher in the junior high classroom where the use of computers was taught: Rule #1: I am always right. Rule #2: When I am wrong, see #1. Warren, in the earlier study also noted the posting of computer terms in the classroom such as: "kill"; "manipulate"; and "abort". These are verbs with limited appeal to most girls and not necessarily of great appeal to many boys unless affirmed.

The current study is consistent with the 1986 study. The computer games that students were encouraged to design in the graphics courses of the computer camp were based on earlier software

games, such as "dungeons and Dragons", all of which contained monsters, battles with the forces of evil, and a large variety of tools of terror and of weapons of destruction. Indeed, one of the classroom directions to students in the construction of their own games was for each to "include some tools, weapons, and other useful objects".

The researchers in both the present study and the earlier one noted that a typical list of objects valued in the graphics/animations courses by male students included: my gun; ray gun; ray gun bazooka; feet; ray mask. For solutions to game problems, males consistently listen only one verb, "shoot" which often was stated more than once in different terms.

In comparison to the boys who preferred to eliminate those forces assessed as evil, the girls chose to use techniques to contain those forces such as magic or negotiation. Thus their word lists of objects needed included: magic wand; gas mask; ring; key; sword; bunny magicians; back pack with chocolate bars; army hat; chain saw; treasure chest with gold; silver; pearls; and diamonds.

Because the language of the computer is based on a binary system, one's interaction with it can be either right or wrong, verified or unverified, supported or unsupported. It inherently supports a dualistic concept which fits well with positivist approaches. In contrast, the experiences sought and valued by most girls are ones which are more relational, depending upon circumstances and people, and contextual rather than clearly dualistic.

The computer curriculum thus can be seen to generally appeal to a normative and empirical framework of understandings in which games and experimental programming contained within such a framework are compatible with the boys' socialization experiences but not necessarily with those of the females.

In analyzing the observational scripts, the different life experiences of the boys and girls and the "ways of knowing" which have been derived from those experiences in order to make sense of those life experiences, means that the girls have strengths and understandings which seldom can be acknowledged or addressed by their interaction with the computer in this setting. The boys, too, come with strengths, for which, more often than is true for the girls, they are

likely to find reinforcement in their interactions with the computer, and reinforcement in the instructional design and curriculum.

Underlying the positivist themes in these instructors' and students' texts is an extremely influential trend which forms the generally accepted view of science and technology as defined by the traditional paradigm. Technology is presented as an objective and "neutral" force divorced from societal norms; a monolithic power claiming to be the arbiter of truth. At the personal level, the claim of its objectivity separates scientific knowledge from any emotional or social commitment. In itself, this theme has done much to alienate females (and many males) who value social commitment from scientific and technological knowledge.

DISCUSSION:

A post-structural feminist critique has allowed us to examine "the text" of a kids' computer camp and to expose systematically unequal power relationships. The implications for a feminist pedagogy suggest redirecting the research on teaching from a technical emphasis on *how* science classrooms function, to *why* they function in particular social, political and gendered ways. Teachers in a classroom offer a model or exemplar for their colleagues and students, and it is useful to examine the epistemological frameworks which they as teachers bring to the classroom (Crocker, 1983). Their conceptual meanings speak to the intellectual climate in the science or computer classroom, for these meanings influence female and male students' knowledge claims.

It is no longer sufficient to simply propose that 'more women enter science' or 'more women need to improve their deficiency in ...', since the conceptual paradigmatic framework of the computer classroom marginalizes girls' experiences. It devalues girls' *episteme* and the very epistemic community from which women their meaning. To this extent, interpretive and critical texts need to be incorporated into the epistemological frameworks of science classrooms. This would provide a platform for transformation that would move beyond postmodernism and enable the development of a platform in which women could constitute themselves as subjects as well as objects.

Such retheorizing has practical implications for the pedagogy of science classrooms.

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PARTICIPATION IN SENIOR LEVEL MATHEMATICS AND SCIENCE COURSES AND THE ISSUE OF GENDER

P. James Gaskell

Une série d'études de cas ont été conduites dans des écoles comportant des taux élevés et d'autres de faibles taux de participation des femmes aux cours de niveau supérieur de mathématiques et de sciences. Certaines différences de base ont été relevées dans la façon dont les cours étaient conçus dans les deux types d'école, mais peu d'attention explicite a été accordée aux questions des sexes dans les cours de mathématiques et de sciences de ces écoles. Une enquête de l'acceptation initiale des filles des stratégies sans distinction des sexes du personnel enseignant, toutefois, révèle le besoin d'approches plus sensibles à l'égard des femmes et des hommes. Il est essentiel non seulement d'aborder la question du contenu des cours de mathématiques et de sciences, mais aussi de la composition des salles de classe.

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PARTICIPATION IN SENIOR LEVEL MATHEMATICS AND SCIENCE COURSES AND THE ISSUE OF GENDER

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ABSTRACT

A series of case studies was conducted of schools with high and schools with low female participation rates in senior level mathematics and science courses. Some general differences were found in the way the courses were constructed in the two types of schools, but there was little explicit attention paid to gender issues in mathematics and science courses in any of the schools. A probing of girls' initial acceptance of teachers' gender neutral strategies, however, suggests the need for more gender sensitive approaches. Not only the content of mathematics and science courses must be addressed but also the complex constructions of gender in the classroom.

INTRODUCTION

This paper explores the construction of senior level (Grades 11 and 12) mathematics and physical science courses in schools with high and low participation rates of females in those subjects. The paper draws on data from a larger study on gender issues in student choices in mathematics and science (Gaskell, McLaren, Oberg, & Eyre, 1993) conducted as part of the 1990 British Columbia mathematics assessment.

There are two distinct ways of thinking about the participation of girls in a course. The participation rate measures the number of girls (or boys or both) enrolled in a course compared to the total number of girls (or boys or both) in the grade. The balance between girls and boys is measured by the male-female ratio which is the ratio of the male participation rate to the female participation rate. The participation rate and the male-female ratio are independent of each other.

In 1988/89, the last year for which we were able to calculate the figures for British Columbia, the female participation rate for Algebra 12 was 28.7%, for

Biology 12, 28.8%; for Chemistry 12, 15.3%; and for Physics 12, 4.2%. The corresponding male/female ratios were Algebra 12, 1.2; Biology 12, .6; Chemistry 12, 1.2 and Physics 12, 3.2.

In order to explore factors which might influence participation rates we selected 12 schools around the province, six of which had higher than average participation rates and six of which had lower than average participation rates. The schools were large and small, and from urban and non-urban areas. We conducted open-ended interviews with 12 girls and 6 boys in Grade 12 in each school as well as interviews with math and science teachers, counsellors, and administrators. We interviewed approximately equal numbers of students who took math and physical science and those who did not.

MATHEMATICS AND SCIENCE IN THE SCHOOLS

In some schools in our study, mathematics and science, particularly physics, were portrayed as very difficult subjects for only top, academic, highly motivated students. Teachers and counsellors had a strong influence on who did and who did not take these courses and actively discouraged students from taking Grade 11 and 12 Mathematics or Physics if there was any sign of weakness in earlier grades.

In contrast, other schools portrayed mathematics and physics as courses accessible to many students. In these schools teachers and counsellors actively encouraged students to take Grade 11 and 12 Mathematics and Physics. These teachers believed students should be allowed to try mathematics and science courses out while at the same time they acknowledged that some of the material is difficult for some students.

In general, the construction of mathematics and physics as courses for only top, academic, highly motivated students was more characteristic of low participating schools than high participating schools. Teachers, students, counsellors and principals in high participating schools were more likely than those in low participating schools to view mathematics and physical science as courses accessible to most students.

Students' descriptions of how mathematics and science were taught and teachers' descriptions of their teaching, along with some classroom observations, revealed how individual teachers approached the notion that mathematics is difficult in different ways. Some teachers viewed mathematics as fun and challenging. They showed that there could be more than one way to approach a problem, they explored alternative solutions with students, and showed how mathematics could be used in analytic and creative ways. In contrast, other teachers emphasized memorization of rules and formulae to get the right answer using one procedure. Associated with this latter perspective is the idea that mathematics is not hard if the student pays attention.

There were also differences in how schools attended to the provision of mathematics and science support services for students. For example, teachers in some schools organized extra help on a regular basis, particularly in mathematics, whereas in other schools students were left to seek help on their own. Some students described teachers as making a special effort to explain problems differently on a one to one basis; others felt teachers were unable to empathize with students' difficulties and were unable or unwilling to explain problems in different ways.

In general, teachers who approached their subject in more creative ways were more commonly found in high participating rather than low participating schools. There also seemed to be more help available to students in high participating than in low participating schools, where students were more often left to fend for themselves when they experienced difficulties.

In some schools mathematics and science teachers, counsellors, and students spoke of a strong relationship between mathematics, physics and chemistry. Mathematics was used as a filter for enrolment in physics and chemistry. In other schools, however, while mathematics and physics teachers, counsellors, and students acknowledged a link between success in mathematics and in physics they believed that superior performance in mathematics was not required for physics. In general, mathematics was more often used as a filter for physics and chemistry courses in low participating schools than in high participating schools.

In general, mathematics and science were seen as esoteric, obscure subjects having little to do with everyday life. Many girls and boys had little understanding of what mathematicians and scientists actually do and struggled trying to explain how mathematics and science are used. The science that is seen as the most relevant, biology, had the highest enrolment. The idea of relevance, however, is gendered. Girls see more relevance in biology and chemistry and boys tend to talk more about physics. Physics is seen as related to the world of production, high technology and cars; biology and chemistry are seen as related to the environment, the body and household substances.

Although it was possible to distinguish some differences between schools with high female participation rates and schools with low female participation rates in mathematics and science, these differences did not necessarily affect the male/female ratio. Indeed, some schools which had high participation of females in math and science had even higher participation rates for males leading to worse than average male/female ratios.

It is not surprising that contexts which produced high participation rates for females did not lead to correspondingly smaller male/female ratios. The approaches taken to improve participation were considered gender neutral. Indeed, gender neutrality, the idea that as long as there was no overt discrimination against girls, and girls and boys were treated the same, was the dominant view of the students, counsellors, teachers and administrators who were interviewed.

PROBLEMS WITH GENDER NEUTRAL STRATEGIES

There are, however, several problems with such a gender neutral approach. It ignores the historical construction of mathematics and science as masculine domains. It also ignores the different experiences that females and males bring to school and the different symbolic and social resources that females and males can draw on in coping with the dynamics of classroom life.

The masculinity of science was evident in both high participating and low participating schools in this study. Most mathematics and physical science teachers and department heads were men. The few visuals in classrooms were

predominantly of male mathematicians and scientists. There was little evidence that any effort had been made to recognize women mathematicians and scientists or to counter the predominance of male images in textbooks or commercial curriculum materials.

A variety of recommendations have been made in the literature for enriching or transforming school science by making it more girl-friendly through including real-life applications and career opportunities (Smail, 1987) or by making it more feminine through creating a classroom environment that places value on caring, co-operation, ethical issues, subjectivity, and the quality of life (Manthorpe, 1982). Bentley and Watts (1986) argue that this repackaging of school science is too narrow and leaves the masculinity of science unchallenged. They argue that school science should support a feminist science that is "particularly humanistic" and re-visions the investigative nature of science itself. Such a feminist science would stress the importance of wisdom, subjectivity, holism, and mystical forms of thought.

An assumption of each of these recommendations, however, is that changing school science to make it more inclusive of girls' interests is all that is reasonably required. They tend to ignore the way that gender is actively constructed inside and outside the classroom in the context of structures of domination and they do not take account of how these structures of inequality interact with the curriculum and pedagogy of school science (McLaren & Gaskell, 1992).

In interviews with the girls an attempt was made to understand how they made sense of their experiences in school science within a contradictory context that simultaneously denies the significance of gender (by believing that schools should be, and in fact are, gender neutral) while at the same time it embodies gender (in its diversity interacting with other dimensions such as race and class) as a major element of experience.

Gender neutrality operates in a social context in which teachers and students share cultural expectations about how normal behaviour is defined differently for males and females. The difficulty of naming and talking about this "double standard" is captured in the following comment:

I: What about the teachers? Do you feel they treat girls, do they encourage the girls as much as the boys?

S: I think it's equal here. Like I said, I've never seen any discrimination between females and males. Of course there is some but you don't see it. Like, I've always had my eyes closed, it seems, to things like that. Let's say a guy will just get suspended or something, but a girl can be expelled for something like, say, swearing at a teacher or something.

This passage eloquently describes the taken-for-grantedness of different expectations for boys and girls and the way these unequal expectations make unequal treatment appear normal and, therefore, difficult for girls to talk about.

Sometimes, while talking, the taken-for-grantedness of gender neutrality begins to appear more problematic:

S: It's just like working with another girl, working with a guy, you know, there's no difference, I wouldn't say. The only thing sometimes you do something wrong and the guy would look at you and go, "Air head." I mean, occasionally you get comments like that, but it's not really that much of a problem, you know. ...

I: When they say something to you like "air head," what do you say? How do you respond?

S: That depends, usually I tell them off. I don't know, I guess I'm used to it by now.

I: What other kinds of things might they say as well as air head?

S: Well, they usually just say that one. ... What happens is, I guess, traditionally girls in [this school] are very what they would consider nerd-like and study, and all that stuff. And now my friends, I mean, we go in there, you know, we have light-coloured hair, blond or whatever and we do other things and we go out and party and do what regular teenagers do. A lot of people sort of react to that, "That's weird, she does that and she does well at school?" So a lot of times you do get called by air head and stuff like that, I don't know, I mean, I'm used to it.

The idea of equal treatment has dissolved into a choice between being considered a "nerd" or an "air head." The fact that being an "air head" was

something that you had to get "used to" suggests that it was not desirable. However, in this context she was not prepared to identify it as a problem. To do so might have jeopardized her determination to do well in science and math while still remaining friends with the boys — an essential element of not being called a "nerd."

Many of the girls had contradictory relations with the boys in physics classes. Though they often talked about their fraught relations with the boys, they also recognized that their friendships with the boys were important and that boys who were "fair" often outweighed the others.

In this study, the girls struggled to meet the demands of school science on its own male-defined terms. They did not disrupt the classroom to ensure that the curriculum addressed 'heir needs. Their responses contrast with those of boys documented by researchers (Eyre, 1991; Walkerdine, 1989). These authors found that boys tend to draw upon the cultural authority of being male to negotiate power with teachers, especially if teachers are female. The girls taking senior physics had less power than the boys in the classroom. They were harassed by some of the boys and were generally confronted with at least two layers of authority—teacher as expert, and teacher as male. The girls were reluctant to challenge the behaviour of the male harassers and saw few alternatives to the present construction of school physics.

CONCLUSIONS

While some general strategies making mathematics and physical science more accessible may help to increase the participation of females as well as males in these courses, these strategies do not take into account the different experiences of girls and boys and the complex constructions of gender in the classroom. There is a need for a gender-sensitive perspective on the curriculum that encourages taking gender into account when it makes a difference in furthering sex equality and ignoring it when it does not (Martin, 1985). Specific approaches from such a perspective will necessarily vary from context to context but are distinct from efforts to construct a feminist science education by first outlining what a feminist science might look like (see for example, Bentley &

Watts, 1986; Rosser, 1990). Longino (1989) cautions against a view of feminist science that encodes a particular world view and assumes a particular female sensibility or cognitive temperament. Such a view denies the diversity of women's experiences and, therefore, frameworks. Keller (1989) also cautions against the hasty embrace of a "different science" that would necessarily replace current science and argues, instead, for a notion of "difference in science" that reclaims a richer, more multi-faceted approach to doing science. Longino and Keller resist the collapsing of the complex experiences of people and science to simple dualities: masculinist science or feminist science. Following Longino, the issue needs to be reframed from a concern with constructing a feminist mathematics or science education to one of constructing mathematics or science education as a feminist.

When constructing school mathematics or science as a feminist, issues of gender, race, class etc. are a conscious and central component of classroom and curriculum discourse; issues of gender, mathematics, science, and school mathematics and science are made problematic. The concerns and ambivalences girls (and boys) and female and male teachers have about gender as an issue in school mathematics and science are brought into the curriculum. Needless-to-say, this is not a risk-free strategy. As Lewis (1990) found, engaging in a feminist critique of classroom dynamics in a male-dominated context may lead to the reproduction of exactly the practices that are being criticized. Feminist practice/politics rather than ameliorating women's feelings of threat may exacerbate them. The challenge remains to develop constructive ways of foregrounding the effects of gender, mathematics and science on girls' lives in school mathematics and science classes.

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Transforming the Curriculum Through Changing Assessment Practices

Gaell Hildebrand and Andrea Allard

Les pratiques d'évaluation utilisées dans l'enseignement des sciences ont souvent tendance à privilégier certaines formes «masculines» de connaissances et de façons de savoir (par ex., J. Harding, 1979 et 1991, P. Murphy, 1989, R. Murphy, 1982, Rennie & Parker, 1991, Hildebrand, 1991). En modifiant ces pratiques d'évaluation, on peut parvenir à modifier **les matières** qui sont enseignées et la **façon** dont elles sont enseignées. Ces pratiques d'évaluation modifiées mettent au défi les façons dont sont structurées les sciences et la compréhension des sexes dans le cadre du programme d'études, modifiant ainsi les expériences et le succès des filles.

Dans ce document, nous examinons les pratiques d'évaluation novatrices du nouveau Victorian Certificate of Education (VCE), enseigné dans les deux dernières années d'études secondaires, soit les 11^{e} et 12^{e} années. Alors que les changements au niveau de l'évaluation dont on parle dans ce document sont communs à toutes les nouvelles matières, nous avons choisi comme «baromètre» la **physique** du VCE. Nous avons choisi la physique parce que les précédents documents de GASAT ont établi que la physique était la science la plus «masculine» pour les filles et, à Victoria, la physique est la science la plus souvent requise en tant que condition préalable dans l'enseignement supérieur.

Le VCE est utilisé en tant que qualification de fin d'études que moyen de sélection dans les établissements d'enseignement supérieur et dans les milieux de travail. C'est une étape d'apprentissage critique, qui concerne le public. Par conséquent, il pourrait être plus simple d'encourager une transformation paradigmatique dans l'enseignement des sciences à cette étape de transition qu'à toute autre étape de l'apprentissage.

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Transforming the Curriculum Through Changing Assessment Practices.

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Assessment practices used in science education often work to privilege some 'masculine' forms of knowledge and ways of knowing (e.g. J. Harding, 1979 & 1991, P. Murphy, 1989, R. Murphy, 1982, Rennie & Parker, 1991, Hildebrand, 1991). By changing assessment practices, it is possible to change what is taught and how it is taught. These changed assessment practices have the power to challenge the ways in which both science and understandings about gender are constructed through the science curriculum and this therefore alters the experiences, and success, of girls.

For this paper, we have examined the innovative assessment practices of the newly created Victorian Certificate of Education (VCE) taught across the final two years of secondary schooling: Years 11 and 12. Whilst the assessment changes outlined in this paper are common to all the new subjects, we focus on VCE physics as a barometer. We have chosen physics because previous GASAT papers have documented its extreme position as the most 'masculine' of the sciences for girls and, in Victoria, physics is the science most required as a tertiary pre-requisite.

The VCE is used as both a schooling completion qualification and as a means for competitive selection into limited tertiary and workforce places. It is thus a critical and publicly accountable stage of schooling. Therefore, it could be easier to have a paradigm shift in science education at this transition phase than at any other phase of schooling.

Rennie & Parker (1991) remind us that efforts to create a more gender inclusive curriculum *"may be negated unless assessment procedures are correspondingly more gender equitable."* (p. 56). As Connell et al (1992) state *"assessment practices are not technical devices which are socially neutral, but social techniques that have social consequences."* (p. 23). By selecting particular assessment devices, we are giving clear messages about what is valued as knowledge and as ways of learning. (Tobias, 1990.)

New assessment processes

The VCE physics curriculum *"is based on the view that learning takes place in the same way physics itself is practised: in a social setting, trying to make sense of problems which matter to people."* (VCAB, 1991b: 8). As assessment issues are central to the whole curriculum design process, they also incorporate physics in its social 'context'. This is a distinguishing feature of the new physics course. One of several specified 'contexts' must be selected as the vehicle for learning the central physics ideas. For example the contexts for 'Movement' are: Aristotle to Newton and beyond; On your own two feet; or Wheels. For 'Nuclear Energy' they are Development of the bomb; or Nuclear power. Students,

individually or in small groups, choose a context for each topic which is of personal interest.

A. Work Requirements:

In the new VCE, the work requirements are the learning activities required for satisfactory completion of each semester unit and *"...the work requirements place emphasis on the interaction between physics, technology and society."* (VCAB, 1991a: 3). They are designed so that by doing these tasks at specified points during their studies, students would, almost necessarily, learn the intended curriculum.

In physics, 6 or 7 work requirements are required for each of the four semester units. Students are given specific details as to how to complete these tasks, although there is some flexibility within the guidelines for teachers to negotiate contexts and focus statements to match students' interests. The new course values different learning approaches and thus a range of ways is provided in the work requirements for students to show evidence of their learning. For physics these include: posters; case studies; self-designed projects; oral presentations; and files of changing ideas.

For example, in the Year 11 topic, Nuclear Energy, those students who have chosen the context, 'Development of the bomb' can complete one work requirement with a written or oral briefing which is a response to a situation such as: *"A group of students from your school is visiting Japan on a study tour, and one of the places they will go to is Hiroshima. They ask your physics class to prepare some information for them on the physics of the atomic bomb and its effect on people."* (VCAB, 1991b: 24). Many other focus statements for this briefing are also possible.

B. Common Assessment Tasks (CATs)

Common Assessment Tasks (CATs) are the basis for judging the quality of the work done in Year 12. All students across the state doing a subject do the same three or four CATs and it is these grades which are used for tertiary selection. For all subjects, at least one work requirement is also a CAT and for physics, CAT 1 and 3 are both also work requirements.

In every subject, one or more CATs is assessed internally at the school level. The CATs graded by the teacher are then subject to an independent verification procedure. At least one CAT in each subject is also assessed under test conditions by external examiners. For physics, Cat 2 and CAT 4 are completed under test conditions.

Table 1: The physics Common Assessment Tasks (CATs):

CAT 1	Extended practical investigation	(internal -due May)
CAT 2	Comprehension and application test	(external -June)
CAT 3	Research project	(internal -due Sept)
CAT 4	Explanation and modelling test	(external -Nov)

Criteria

Each Common Assessment Task has clearly stated criteria which are used to distinguish between achievement levels and hence determine the grades on a ten point scale. Such explicit criteria enable students to be focussed in their work.

Three of the nine criteria for CAT 3, Research Project, in physics are: *"The extent to which the report ...explains and discusses concepts through: synthesis and integration of relevant ideas; communication of the understanding gained; identification of related technological and social issues."* (VCAB, 1991a: 38). CAT 3 must be presented in the form of a scientific poster, and it should examine one of the following:

- *everyday situations (e.g. sailing, bicycles, ballet)*
- *physics related to other forms of knowledge (e.g. biophysics, geophysics)*
- *issues of social or personal importance (e.g. safe road design...)*
- *development of ideas in physics... making reference to social and/or technological implications*
- *technological applications (e.g. lasers, jogging shoes, electrocardiograms)*
- *the work of physics related laboratories, industries or professions (e.g. ...designing and manufacturing sound systems, physiotherapy)..."* (VCAB, 1991a: 35.)

How has the assessment transformed the curriculum?

The actual physics curriculum statement is not markedly different from that in other similar level courses. It includes: light, heat, sound, electricity, electronics, motion, forces, structures, radioactivity and nuclear energy, etc. Whilst it does specify real world 'contexts' within which all the central ideas of physics should be taught, many other physics courses also suggest this to teachers. The difference here is that the integrated assessment processes created by the work requirement system necessitate new approaches to curriculum planning and implementation. That is, in order to enable students to satisfactorily complete the prescribed work requirements, teachers must base all the central ideas in one of the available contexts.

Also, as the work requirements demand a range of learning activities, a broader repertoire of teaching strategies must be employed. These new teaching approaches are being disseminated across Victoria through an extensive teacher professional development program. One important component of this has been the 'Verification Days'. On these days teachers in a region are released from their classes to compare gradings on the internally assessed CATs. These days have assisted teachers to develop confidence in their own assessment skills and they have also become an additional means of sharing ideas and strategies for teaching.

Together, these changes have meant that girls experience a physics curriculum which is very different from that of the old course. Women and girls *"would respond better to science if more co-operative and interactive modes of learning were part of the pedagogy"* reports Tobias (1990: 70). An example of one new teaching strategy used in the Nuclear Energy topic is *"a role play of people at a public meeting held to decide if a nuclear power plant should be built in the area."* (VCAB, 1991b: 15). Teachers now also use brainstorming, creative writing, jigsaw techniques for co-operative learning and other McClintock

Collective teaching strategies. (see Gianello, 1988, Lewis and Davies, 1988, Hildebrand, 1989). This radical shift in the conceptualisation of assessment processes means it is no longer possible to teach physics in the old ways.

Has this transformation been good for girls?

1. Participation of girls in physics:

In 1970, 16% of all girls and 49% of all boys chose to study physics in Year 12. (See Note 1). By 1985 this had declined to 8.9% of girls and 34.8% of boys. This pattern remained relatively stable for the final years of the old course. But for 1992, the first year of the new course in Year 12, the proportion of girls increased with 9.4% of all girls choosing the new physics course; the corresponding figure for boys continued to decline to 28% of all boys. Whilst there are obviously still many more boys than girls studying physics, the new course has made a small shift in the participation of girls.

2. Achievement:

a) Satisfactory Completion or Passing Grades:

All items on the external exam of the old physics course (which dominated the entire grading system) were dichotomous response: either multiple choice or numerical answers. Between 1970 and 1985, the percentage pass rate for boys in Year 12 physics was consistently greater than 3 points above that for girls. When the research (e.g. J. Harding, 1979, R. Murphy, 1982) clearly suggested that this examination format might effect girls, some extended response questions and social context questions were included in the papers at the end of the eighties. This did have an impact on the overall success rate of girls so that in 1991 (last year of old course) 87% of girls and 84% of boys passed.

With the new VCE physics, 97% of girls satisfactorily completed, whilst 94% of boys did so. This 10% increase in one year suggests that the work requirement system is more accessible and equitable for all students.

b) Excellence:

The most dramatic impact of all the changes in physics however is in the sudden capacity of girls to demonstrate 'excellence' as is evidenced in the awarding of A grades.

Under the old system, from 1970 to 1985, the percentage of boys awarded A grades was consistently more than 8 points higher than the corresponding figure for girls. For example in 1985, 11.5% of girls were awarded A grades whilst 20.7% of boys were so rewarded. This gave fuel to the argument that girls just could not do physics very well! With the advent of the new extended response and social context questions in the exam, the margin narrowed so that by 1991, there was only a difference of 4 points, still in favour of boys (14.3% of girls and 18.1% of boys received A grades).

Table 2: Year 12 Physics 1992 - Percentage A grades by Sex:

Common Assessment Task	% of Girls awarded A grades	% of Boys awarded A grades	Internal or External mode
CAT 1 Extended practical investigation	27%	20%	internal grade externally verified
CAT 2 comprehension and application test	17%	17%	externally set and marked exam
CAT 3 Research project	36%	28%	internal grade externally verified
CAT 4 Explanation and modelling test	18%	16%	externally set and marked exam

The remarkable change is in the grades awarded for the CATs in 1992. **Girls achieved excellent results in all CATs and were never outperformed by the boys.** In particular, for the two internally assessed and externally verified CATs, the girls results were considerably better than the boys. This confirms the work done in Western Australia by Rennie and Parker, (1991), which showed that girls did better on internal assessments.

One of the physics curriculum specialists (Firkin, 1993) places much of the credit for the shift to the style of assessment which *"does seem to allow girls to show what they know and what they can do much better than the old system"*. She also suggests that the first CAT, the internally assessed extended investigation, has a confidence boosting effect for girls which continues into the test CATs. Firkin stresses that the course itself is no less rigorous or difficult. She also reports that the, as yet unreleased, statistical analysis of the whole new VCE , both for Year 11 in 1991 and Year 12 in 1992, shows that girls have done better than boys in almost all curriculum areas.

Does this curriculum transformation go far enough?

The changed assessment practices which have, in turn, influenced the curriculum and pedagogy of the new VCE, reflect notions of a gender inclusive curriculum which have been articulated in a range of sources, (e.g. Gianello, 1988, Lewis & Davies, 1988, Hildebrand, 1989, Rosser, 1990). In particular assessment practices contribute to the successful learning for girls when teachers: *"...provide for a range of learning styles; are explicit about the outcomes they are working towards, and the criteria they will apply for assessment; encourage students to compete against themselves rather than against others; allow students to have some control over the pace and direction of their learning; use assessment processes which are related to progress."* (Australian Education Council, 1992: 14).

While there are grounds for celebration, especially in the way feminist educators, such as McClintock Collective members, have been able to influence the design of the new VCE structure, a number of other concerns remain.

There are dangers in broadly generalising about which curriculum/assessment practices are 'good for girls' without addressing the issues of difference within the category of 'girls' (Allard, 1992). Ethnicity, socio-economic factors and race all work to construct a range of understandings about appropriate 'feminine' or 'masculine' behaviours. For example, some research (Jones, 1989; Wyn, 1988) suggests that girls from lower socio-economic backgrounds actively resist pedagogical and assessment practices based on *"interpretation, exposition and independent work"* (Jones, 1989: 29), precisely those practices which are now being given greater status.

Table 3: Stages of Curriculum Transformation (Schuster and Van Dyne)

STAGES	QUESTIONS
1	Invisible Women/absence not noted: Who are the truly great thinkers/actors in history?
2	Search for the missing women: Who are the great women, the female Shakespeares, Darwins?
3	Women as disadvantaged/subordinate group: Why so few women? Why are women's roles devalued?
4	Women studied on own terms: What was/is women's experience? What are the differences among women?
5	Women as challenge to disciplines. How must our questions change? Testing the paradigm. Gender as a category of analysis.
6	Transformed/'balanced' curriculum. Inclusive vision based on diversity of human experience, not sameness & generalisation.

Unless the limits of the gender inclusive curriculum approach are understood, this type of generalising about 'preferred ways of learning' can serve to reinforce rather than to challenge stereotypes about females/males. It can 'naturalise' differences rather than work to critically examine the ways in which these differences are constructed individually and collectively. We need to look at difference within either sex and recognise the multiple realities that are produced by the intersections of gender with ethnicity, class and race. The move to more 'gender inclusive' practices in the VCE curriculum and assessment processes may be seen as a stage along the way in transforming the entire curriculum. Considering the model developed by Schuster and Van Dyne (1984), these practices probably represent the transition from the fourth to the fifth stage of change. This then suggests further possibilities for action.

Another way of considering where such changes in assessment practices have placed our understandings about girls and education may be found in Kristeva's three tiers of feminism (1981). These are briefly summarised in the following Table.

Table 4: Tiers of Feminism (Kristeva):

1. **Liberal** feminism- equal access and success in the public domain; rejection of the treatment of women as a separate/oppressed class.
2. **Radical** feminism - celebrates 'women's ways of knowing' (Belenky et al, 1986); the 'feminine' extolled.
3. **Post-structural** feminism - rejection of the male/female dualism as metaphysical. Different positionings in different contexts; contradictions and resistances are both possible; there is no longer pure 'truth' but multiple, subjective voices create meanings.

Kristeva's third tier appears to partially correspond with Schuster and Van Dyne's Stage 6 although it does suggest a move beyond gender as a category of difference and hence proposes further change directions. This tier considers the ways in which, individually and collectively, people continually negotiate, resist, challenge and reproduce meanings through a variety of discourses, including those evident in schooling. Through this they thereby work to construct their own understandings of 'appropriate' masculine or feminine behaviours.

In the VCE physics course, scientific knowledge is viewed not as an objective or universal truth, but as a social construction (e.g. Keller, 1985; S. Harding, 1991; VCAB, 1991a, 1991b); yet it still does not encourage deconstruction of the common oppositions that have become associated with masculine and feminine. *"Not only are mind and nature assigned gender, but in characterising scientific and objective thought as masculine, the very activity by which the knower can acquire knowledge is also genderized"*. (Keller: 1985: 79). The following dualisms are still evident in the physics course: the knower (Mind)/the knowable (Nature); rational/emotional; objective/subjective; quantitative/qualitative; abstracted/holistic. It may be possible to rethink such dichotomies and to view them as points along a continuum. The possibility of considering how different groups of people position themselves along such continua, and the ways in which science and education inform these positions, is opened up by Kristeva as another phase of change.

The new VCE does provide a small crack in the dominant paradigm of what is acceptable science education. There is evidence that some schools are already using the new approaches to fully integrate assessment into the junior school curriculum in order to facilitate learning rather than simply measure it. These may gather sufficient momentum to encourage more girls to continue their study of science into the VCE but this then raises a far more difficult problem. Tertiary science courses are still rampantly masculinist, including those in our own institution, and their assessment modes are still traditional, objective-based, quantitative, problem solving examinations. Notions of academic 'freedom' ensure that these practices remain outside critical scrutiny.

Yet the innovative assessment processes at the end of Year 12 have become subject not just to educational, but community-wide, scrutiny. The dual roles of assessment for learning and assessment for selection are highlighted by Yates (1990) when she says: *"...schooling as an institution combines two elements which both educational theorists and feminist theorists have found very hard to put together. State systems of education always have*

some involvement in selection and certification of people ...and they also always have some involvement in teaching them things." (p. 49)

This tension between the two roles of the VCE creates a dilemma: on the one hand, it enables new prescribed assessment practices to become rapidly adopted by teachers, consequently changing the curriculum in a short time-frame. However, since the VCE is also used as an external measure of 'success' by the community, those with vested interests in maintaining the status quo continue to publicly and powerfully resist these changes. They may have a concern that the new VCE assessment practices have the potential to 'open up' the tertiary selection process to those not traditionally advantaged. The major role that assessment practices play in providing access to powerful positions (which are often constructed as masculine) needs to be understood and re-conceptualised. *"Men in general seem to have too much invested in their positions as authoritive knowers to be able to recognise this: it is thus largely up to women to challenge the norms and ideals within which they were trained in order to seek other ways of knowing, other techniques of proof, and perhaps another status for science."* (Grosz and de Lepervanche, 1988: 26.)

Within the context of an election campaign, the right wing public criticism of the new VCE credential led to a review, in December, 1992 of the assessment processes. The report endorsed the 'ideals' of the VCE system but proposed that internally assessed CATS be accepted only if they are statistically consistent with the students' grades for the external CATS. Thus, again, external grades are perceived as a more reliable indicator of success than those assessed by the teacher. As many girls do score higher on internally assessed work (this paper and Rennie and Parker, 1991), the proposed modifications could be read as privileging the masculine.

Yet, despite conservative resistance, we have shown here that gender inclusive changes in assessment practices can lead to significant transformations in girls' experience of, and success in, the science curriculum. Thus changes in assessment practices which lead to a transformed curriculum can shift our understandings of both science itself and the construction of gender.

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Notes:

1. All statistics in this paper came from: VCAB (1992), Hildebrand (1987) or Firkin (1993).
2. VCAB is the Victorian Curriculum & Assessment Board
3. VCE is the Victorian Certificate of Education.
4. CAT is a Common Assessment Task.

LONGITUDINAL STUDY OF A MIDDLE SCHOOL PHYSICAL SCIENCE INTERVENTION PROGRAM

Trish Yourst Koontz

Cette étude longitudinale a été effectuée auprès de 40 étudiantes de sixième et septième années après la conclusion d'un programme d'intervention sur l'égalité des sexes. Vingt filles ont participé à des activités pratiques de physique et d'informatique, ont rencontré des modèles à imiter au sein de l'industrie et se sont jointes à des activités de visualisation spatiale, deux fois par semaine pendant un an. Le groupe témoin était composé des vingt autres filles. Bien que le pré-test n'ait permis de relever aucune différence importante dans les attitudes ou les aptitudes entre les membres des deux groupes, la différence était significative au post-test de la fin de l'année d'activités et six ans après, à l'occasion d'un post-post-test. Le nombre de cours de mathématiques et de sciences terminés et les attitudes générales à l'égard des mathématiques et des sciences se sont largement améliorés dans le cas du groupe étudié. Le programme d'intervention n'a pas semblé avoir une grande influence en ce qui concerne les ordinateurs, ni au moment du post-test, ni au moment du post-post-test. Le groupe étudié et le groupe témoin ont adopté des attitudes plus ou moins négatives à l'égard des ordinateurs et de leur propre utilité au-delà du traitement de textes.

LONGITUDINAL STUDY OF A MIDDLE SCHOOL PHYSICAL SCIENCE INTERVENTION PROGRAM

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ABSTRACT

This longitudinal study surveyed 40 sixth and seventh grade females six years after a gender equity intervention program was completed. Twenty girls experienced hands-on physics and computer activities, contacts with role models for industry, and fun with spatial visualization activites twice a week for 1 year. The control group consisted of the other 20 girls. Even though there was no significant difference in either attitude or aptitude between the groups as identified by the pretest, there was a significant difference at the years end posttest and 6 years later on the post-posttest. The number of mathematics and science courses completed and the general attitudes toward mathematics and science significantly improved for the experimental group. The intervention program did not prove to have any significant influence dealing with computers on either of the post or post-posttest. Both the control and experimental groups held moderately negative attitudes toward computers and their personal usefulnes beyond word processing.

INTRODUCTION

Several recent documents stress the needed to encourage underrepresented groups to participate more fully in mathematics, science and computer related careers (Rutherford, 1990; NCTM, 1989; NRC, 1989; AAAS, 1989; MSEB, 1991). Many professional organizations are recommending a "core curriculum" in which all students must participate. This strategy may help underrepresented groups become more computer, science and mathematics literate, but is this enough to encourage underrepresented groups, such as females, to enroll in advanced courses beyond what is considered core and to strive for a career in one of these three areas.

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Middle school years seem to be critical years for females in their decisions to continue in advanced studies of computers, mathematics, and science. Intervention programs have focused on determining techniques that encourage females to like, appreciate, and understand these subjects. Many intervention programs have been acclaimed for reaching such goals. The programs are designed to offer more gender inclusive curriculum, contacts with role models, hands-on experiences and promotion of self-esteem in females. Some of these many programs include: EQUALS, Operation Smart, The National Women's History Project, Gender/Ethnic Expectations and Student Achievement (GESA), Choices Curriculum, Activities that Integrate Math and Science (AIMS), Women in Mathematics (WAM), Career Oriented Modules to Explore Topics in Science (COMETS), Equity in Mathematics, The McClintock Collective Network, and the Computer Equity Training Project. Some of these projects have studied the effects of participation in the program on females after they have completed participation, and most have been able to document short term positive effects. For example, the Computer Equity Training Project reported increasing voluntary computer use by females 144% in the experimental schools but little or no change was found in the control schools (Lockhead et.al, 1985). EQUALS also reported a modest improvement in attitudes toward mathematics and science by the students involved. However, many of the programs have little or no formal evaluation plan in place and fewer conducted longitudinal studies to determine any possible long term effects of the program.

The present study was designed to determine if an intervention program during the critical middle school years has any long term

impact on females attitudes toward and participation in advanced high school mathematics, science, and computer courses.

METHOD

The initial population consisted of 30 sixth-grade females and 30 seventh-grade females who were selected based on their positive attitudes and past high grades in mathematics and science for the initial round of the study. This group of 60 students was administered the Ross Test of Higher Cognitive Skills and the Group Assessment of Logical Thinking (Galt), a Piagetian task test. The top 20 scorers of each grade level were then selected for the formal part of this study. Half of each grade level was randomly placed in the control group(2) and the other half in the experimental group (2). Data was only available on 17 of the experimental group and 15 of the control group for the 6 year follow-up. Therefore statistics will only be analyzed for the 32 instead of 40 girls. The experimental group was named ERG for Enrichment Readiness for Girls. Erg is a unit of measure of potential energy and thought an appropriate acronym for the experimental group. The differences between the means (M_1=22.35, SD_1=4.35; M_2=21.53, SD_2=2.94) of the cognitive tests were analyzed by use of a *t* test and found to show no significant difference between the two groups (t=.41, df=30, p=NS).

A 25 question attitude survey was conducted on all forty girls prior to the start of intervention. The informal test examined their feeling and perceptions about mathematics, science and computers in general, these subjects importance in future careers and again as classes in school. The girl's perceptions about parental expectations about grades along with there perceptions of how smart their parents were in

mathematics, science and computers were queried. Again no significant difference was found between the means of the attitudes of the ERG or control group when a 2-tailed pooled variance *t* test was performed on feelings toward mathematics, science, computers, or perceptions of parents (See Table 1). A forced choice Likert-type survey was used. Strongly Agree=4, Agree=3, Disagree=2, Strongly Disagree=1, were used as answers to questions such as I like science.; Science class is fun.; Science is important to get a good job.; and Boys do better in science than girls. Similar questions are used for computer and mathematics.

Table 1. Pretest Means and Standard Deviations

	N	M	SD	*t*	significance *p*=.05 level *
Control	15	3.03	.45		
Math Attitude				-1.01	NS
ERG	17	3.16	.32		
Control	15	2.98	.51		
Science Attitude				- .23	NS
ERG	17	3.01	.52		
Control	15	3.00	.75		
Computer Attitude				- .77	NS
ERG	17	3.18	.53		

The ERG group met twice a week for an academic year, 9 months, to participate in the following type activities:

(1) hands-on science projects in physics content areas that stressed the need for mathematics and use of the computer. Examples include insulation experiments using computer temperature probes, rocketry, gear ratios using Logo-Legos, circuit studies and special attention to spatial visualization puzzles.

(2) experiments with computer interfacing to discover and use computers beyond drill and practice. Examples include light and temperature probes, data bases, building a binary bit counter interfaced to the computer.

(3) Communications with female role models through classroom visits, and on-site field trips to local businesses and industries.

At the end of the 9 months the same attitude test was administered to both the ERG and control groups as a posttest. Five and a half years has since passed and the ERG and Control groups are once again asked to complete the survey, a post-posttest. Both of the post and post-post attitude tests consisted of 15 of the original 25 survey questions. Ten of the original questions were asked in two similar way but placed at different locations on the pretest to verify their feelings. Since there was a high correlation between the similar questions it was felt that the girls indeed took the survey seriously. Only 15 questions were then used for the subsequent two post tests. Four questions each dealt with feelings about liking mathematics, math classes, and the usefulness of math. Similar questions were repeated about science and computers. The remaining three questions dealt with perceptions about parents and reading.

High school counselors provided a list of courses each of the 40 girls have completed in mathematics, science and computer areas. In addition, the ERG group was also asked to describe what they most remembered about the intervention class.

RESULTS

Table 2 shows the means, standard deviations, t values, and level of significance of the pooled variances between the two groups to analyze the relationships between courses completed and attitudes about mathematics 5 1/2 years after the intervention program.

Courses taken were placed in a hierarchy. The following scale was used:
Mathematics (each level includes the prior courses):
1=Alg.I and Geometry, 2=Alg.II, 3=Statistics 4=Pre-calc with no statistics, 5=stat and pre-calc, 6=Calculus, 7=Adv. Placement Calculus.
Science(each level includes the prior courses):
1=general science or geology, 2=biology, 3=chemistry, 4=biology II,

5=physics instead of biology II, 6=advanced physics/physicsII, 7=any 2 advanced placement courses.
Computer (each level includes the prior level):
1=no courses taken, 2=intro to computer software, 3=programmingI, 4=programmingII.

Table 2. Means and Standard Deviations Between Groups for Mathematics, Science, Computer Attitudes and Courses Completed

	N	M	SD	t	significance p=.01 level **
Control	15	3.40	1.55		
Math Courses				-3.10	**
ERG	17	5.06	1.48		
Control	15	3.07	1.10		
Science Courses				-2.78	**
ERG	17	4.47	1.66		
Control	15	1.40	.51		
Computer Courses				-1.24	NS
ERG	17	1.76	1.03		
Control	15	2.72	.31		
Math Attitude				-3.87	**
ERG	17	3.21	.40		
Control	15	2.73	.38		
Science Attitude				-4.58	**
ERG	17	3.35	.38		
Control	15	2.93	.46		
Computer Attitude				-.34	NS
ERG	17	3.00	.61		

At the .01 significance level there is a significant difference in both attitude and number of courses taken in mathematics and science between the experimental ERG group and the control group. However, there was no significant difference between the groups pertaining to attitudes about computers or computer courses taken.

Since the pooled questions showed significance between the two groups, a *t* test for each question was analyzed to further clarify the

significant differences in attitude during the post-post test. The ERG group became significantly more positive about science classes even though their attitude about science remained constant. However, the control groups attitude toward science classes became significantly more negative (M=2.33, SD=.72) even though their general attitude about science remained moderately positive (M=3.06 SD=.45).

In mathematics the ERG group tended to become slightly more positive about math in general and mathematics classes. The control group, too, remained slightly positive about math in general but they became significantly less positive toward the mathematics classes. Only the control group became significantly more convinced over time that boys do better in math than girls. Both the ERG and control groups felt math was very important to get a good job during the pre-test 6 years ago. However, both now feel it is only somewhat important. There was a significant downward change in perception of the importance of mathematics to secure a good job for both groups. The importance of reading significantly rose for both groups from moderately important to very important. Knowledge of computers remained consistently less important throughout the 6 year study. Combining the two groups and controlling for their differences a correlation was performed to investigate the relationships, if any, among math, science, and computer courses taken and the attitudes between these 3 areas. The attitudes about the subjects correlated highly with the number of courses in that area taken. During the open ended part of the survey two of the 17 ERG students commented that the more high school science courses they took, the more they liked science. They commented on how their teacher made it exciting.

CONCLUSIONS

The results clearly support the proposition that middle grade intervention programs that give hands-on experiences, role model contacts, and encouragement to girls positively influence girls attitudes and course selection dealing with mathematics and science. The results did not support the hypothesis that attitudes and achievement in computer classes were also positively affected by the intervention. Several of the ERG girls wrote in open ended statements on the post-posttest that even though at this time they were not planning on math or science careers, they felt they could change their minds since they completed four years of mathematics and science in high school. Many of these girls reported that their love for math and/or science started with the ERG program; "It was different from book science." Several ERG girls also stated that until being selected to be in the ERG program, they never thought of themselves as liking or being good in math or science. "It really built my self-esteem." Although this particular study only qualitatively hints at self-esteem as a major factor, I suspect the self-esteem issue was of greatest importance. Once the ERG girls were "given permission" to feel comfortable as students of math and science they then continued with advanced courses. From the open ended responses it also becomes apparent that with good teachers girls continue to take advanced courses because the subject itself and the teachers are exciting. They seemed to have to be encouraged over a critical time to continue. Once they persisted it became self sustaining to continue in their junior and senior years.

On the other hand, the control group with equal initial ability and attitudes, did not receive the encouragement. And the control group as

indicated by the survey bought deeper into the myth over time that boys are smarter than girls in mathematics and science.

The ERG intervention program seem to only have short term effects on the girls attitude and course selection dealing with computers. The post-posttest indicated no significant difference between the ERG or control groups and that both groups' feelings were on the moderately negative side for attitudes and usefulness about computers. All of the girls indicated liking and using the computer for word processing. Some indicated using the computer for art class but only one enjoyed using the computer beyond word processing or art. As computers become even more prevalent in everyday society and not just in the office, I am optimistic that computer use can also be encouraged through middle school intervention programs. More ideally, I look forward to research and programs that study the effects of gender inclusive curriculum and equitable teacher behaviors within the classroom to replace the need for intervention programs.

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USING TEACHING STRATEGIES FOR A BETTER PHYSICS EDUCATION FOR FEMALE STUDENTS AGED 14 - 15 IN GENERAL SECONDARY EDUCATION

Magda Man in't Veld & Theo Wubbels

Dans ce document, nous parlerons d'un projet de recherche qui a été mis sur pied en 1990 à la suite d'une étude de Ton Jörg et de nous-mêmes sur les causes de la faible popularité de la physique chez les filles dans les deux premières années de leur éducation. Après un bref résumé des résultats de l'étude précédente, nous parlerons des questions et de la conception de l'étude du projet actuel, qui consiste en deux études de cas, dont des interventions dans les cours de physique dans deux écoles différentes. Deux autres écoles collaborent au projet sans interventions. Certaines données intéressantes seront présentées.

De nombreuses suggestions sont faites dans les ressources documentaires en vue d'améliorer l'enseignement de la physique pour les étudiantes des écoles secondaires danoises. Nous avons cherché à savoir si les stratégies proposées aux enseignantes et enseignants étaient déjà utilisées par d'autres enseignantes et enseignants qualifiés ou si elles et ils pourraient éventuellement les adopter si on le leur demandait et, le cas échéant, s'il était possible de déceler un impact sur l'appréciation des étudiantes et étudiants de l'enseignement de la physique, sur leur intérêt dans le domaine, la perception de la pertinence de la physique dans leur propre vie et sur leur choix facultatif de la physique.

Le document de recherche est disponible auprès des auteurs.

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USING TEACHING STRATEGIES FOR A BETTER PHYSICS EDUCATION FOR FEMALE STUDENTS AGED 14 - 15 IN GENERAL SECONDARY EDUCATION

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In this paper we will report about a research project, which started in 1990 arising from earlier research of Ton Jörg and ourselves into the causes of unpopularity of physics among girls during their first two years of physics education. After a short summary of the results of this previous research, we will describe the research questions and design of the present project which consists of two case studies including interventions concerning physics lessons at two different schools. Two other schools cooperate in the project without interventions. Some interesting data will be presented.

Many suggestions have been formulated in literature to ameliorate physics teaching for female students in Dutch schools for secondary education. We were interested to know whether the suggested strategies for teachers were already practised by experienced teachers or possibly could be adopted by them on our request and if so whether it would be possible to detect an effect on the students' appreciation of physics education, on their interest in physics, the perception of relevance of physics for their own future lives, and their optional choice of physics.

EQUITY AND ASSESSMENT

Patricia Murphy

L'évaluation a toujours joué un rôle important dans l'enseignement secondaire au Royaume-Uni. Les valeurs relatives à l'évaluation déterminent la façon dont les matières sont définies et les facteurs qui déterminent le succès dans ces matières. Depuis la fin des années 1980, des directives nationales d'évaluation ont été mises en oeuvre partout au Royaume-Uni.

L'introduction de ces directives coïncide avec les modifications radicales apportées à la structure du système d'examen public. Le Standard Grade en Écosse et le GCSE en Angleterre et au Pays de Galles (mis en oeuvre en 1988) étaient basé sur des critères nationaux. Ils reflétaient un éloignement de la norme traditionnelle - la pratique de référence. Afin de se baser sur un critère solide - les travaux de cours d'évaluation de référence (c.-à-d., l'évaluation continue) sont devenus un élément majeur du nouveau système d'examen. La rhétorique politique associée à chacune de ces initiatives d'évaluation soulignait l'équité comme une préoccupation majeure. Une *véritable* évaluation des accomplissements et des besoins de *tous* les enfants était considérée comme un moyen de parvenir à l'égalité des chances et du traitement dans les écoles.

Ces développements en matière d'évaluation ont fourni une source de données valables pour expliquer les différences entre les sexes aux élèves et au personnel enseignant et modifier leur perception de l'accomplissement. Toutefois, en raison des récentes modifications des politiques gouvernementales, ces données *n'ont pas* été publiées.

Le document décrit et analyse certaines de ces données pour révéler les iniquités dans les performances qui indiquent clairement comment les partis pris dans le programme d'études et dans son évaluation peuvent affecter les élèves. Plus particulièrement, ce document se penche sur les résultats d'une récente étude du design et de la technologie dans le cadre de laquelle on s'est aperçu que les filles avaient de meilleurs résultats que les garçons dans plusieurs domaines, et regroupe ces constatations avec d'autres constatations similaires dans le domaine des sciences (Kimbell et al 1992; Murphy 1991). Par le biais de diverses initiatives, on peut représenter graphiquement l'influence des perceptions des enseignantes et enseignants des accomplissements des étudiantes et étudiants et documenter le manque de sensibilité aux questions d'égalité soulignées par des spécialistes en évaluation et par des technocrates (Murphy, sous presse).

Equity and Assessment

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Abstract: Assessment in one form or another has always been a critical element of any resourced educational system. Assessment can take many forms and what is chosen and implemented in any single system affects fundamentally how achievement is defined and consequently which students succeed. In this way assessment helps determine the form and organisation of education and serves as the mechanism by which society affirms what is valued in education. Assessment is therefore as central to the equity debate as equity issues are to assessment. The paper looks briefly at the various definitions of equal opportunities and how simplistic notions of bias in assessments have distracted attention from the wider issues of equity. The paper focuses on the messages emerging about sources of gender differences in performance in science and design and technology. These are then used to analyse recent policy shifts in assessment practice in England and Wales.

Defining Equity: Equal opportunities in education prior to the sixties was usually characterised as equality of resources or curriculum provision. However this view shifted when it became evident that educational opportunities were not equally accessible to all groups. Hence the more recent focus on equal opportunities in terms of equal educational outcomes (see for example Coleman 1966). In this view the responsibility to create achievement rests with the institution not the student; equality of output is determined not by the resource inputs alone but by the effectiveness of schools' influence in bringing about achievement. Equality of outcome as a measure of equity continues to prevail in national policy in the USA, Britain and Europe. However the goal of equal outcomes must, according to Levine (1975) be seen as distinct from, and partially conflicting with, the goal of equal opportunity. Individual outcomes in a competitive system will be unequal; only when the barriers that comprise unequal opportunity have been eliminated will equality of results take precedence over inter-group differences and equality of opportunity (p 319).

At present there are at least three views of equality effecting assessment. Equality of outcome remains an implicit perspective both in the way assessments are developed and how sub-group performance is interpreted. This is evident in the comparative reporting of NAEP survey results by gender and ethnic and racial groups (Mullis et al

1990). Critics of this approach to equality have developed a second anti-sexist and anti-racist perspective which challenges the unequal power relations between groups. Adherents to this view aim to transform the patriarchal and ethnocentric nature of school structures and curricula in terms of what is learnt, how it is learnt and how it is valued in assessments (Weiner 1990). A review of recent public policy in the USA, Britain and Australia reveals a third perspective which reflects a radical move away from a concern about group oppression and disadvantage to a focus on individual choice within a 'free market' perception of the education community (Apple 1989). In this view low achievement is once again the responsibility of the individual rather than the educational institution. This paper is concerned with equity. The concept of equity in assessment does not presume identical experiences for all but seeks to (i) ensure that assessment practice enables individuals and groups to reveal their achievements and (ii) that interpretations of results are valid and just for all groups.

Bias in relation to assessment is generally taken to mean that the assessment is unfair for one particular group or another. An item is, therefore, biased if two individuals with equal ability but from different groups do not have the same probability of success on it. This simplistic view does not take account of the differential experiences of sub-groups which might effect their interaction with assessment items and hence alter what is being assessed. The UK. national assessment proposals (DES 1988) recommend that bias should be eradicated from items but as Murphy points out:" This [recommendation] presupposes that we can detect and isolate bias in assessment items and that information from such items does not inform curriculum planning .... Underlying this recommendation is the view that tests based on equity should be constructed to give equal average scores for such groups as boys and girls. This approach accepts gender differences in performance as artefacts of test items rather than indicative of a particular view of achievement" (Murphy 1990 p2). Goldstein (1992) argues similarly that group differences can arise from the construction of the assessment itself and the interaction between the assessment and the groups tested. He concludes that bias is an unhelpful term and recommends the use of the term differential performance. In this discussion of equity and assessment

the central concern is with construct validity i.e. the justice of the inferences made on basis of the assessment.

Developments in assessment: Assessment for selection has a long history and grew out of the psychometric paradigm which assumes that individuals possess a fixed measurable level of intelligence that determines intellectual development and so can substitute for, and predict, achievement. It was further assumed that general intelligence was represented in the population normally. The 1980s saw the emergence of a new approach to assessment based on a quite different conception of intellectual development.. Educational assessment presumes that many achievements are attainable by all students but how and when they attain them will vary from individual to individual. Such assessment is criterion-referenced to provide the 'users' of the education system with a detailed breakdown of student competencies which more fairly represents all students' achievements. Criterion-referenced assessment can also serve both summative and formative purposes: that is provide information about the nature of students' progress and difficulties to facilitate curriculum planning. To achieve these purposes in England: new methods were introduced to public examinations i.e. the use of continuous assessment and records of achievement; national achievement criteria were defined across the curriculum from ages 5-16; and continuous teacher assessment of students across the phases of schooling was made a statutory requirement (DES 1988). This integration of assessment with learning was seen as a significant step towards achieving equity in education.

These educational aims also served a quite different political end which sought to make schools more accountable and prioritised assessment as a means of controlling the curriculum. To achieve the political ends the national criteria were organised, and legislated for, as a system of hierarchical levels of achievement defined by the expected achievement of the population at ages 7, 11, 14 and 16. Compulsory testing at each age using standard assessment tasks was introduced to moderate teacher assessments by providing 'standardised' measures of achievement. The view that a single assessment system could serve both educational and political goals received widespread criticism. These policy led initiatives occurred against a backcloth of

emerging research findings and intense action research which focused on ways of integrating assessment with learning. We consider some of these findings next.

Differential performance - evidence and explanations

Science: In international surveys of science achievement boys have tended to do better than girls in nearly all countries more so at age 13 than at 9. England is an exception as in 1990 there were no significant differences between girls' and boys' performance in contrast with earlier surveys. National science surveys (e.g. NAEP in the USA; APU in the UK.) show a similar male advantage that increases with age but which is confined to aspects of the curriculum. In both the USA and the UK surveys for example males outperformed females on tests of the application of physics concepts. Girls in the UK, however, outperformed males on practical tests of making and interpreting observations. Fluctuations over time in the magnitude and direction of gender differences are not uncommon. The Scholastic Aptitude Test - verbal sections for example, have shown a steady decline in female scores with the earlier female advantage now reversed. These fluctuations rather than indicating genuine changes in achievement levels have revealed how shifts in the test population and test items influence outcomes. However in reports of such surveys it is generally assumed that differences in performance reflect real differences in achievement and that items do not contribute to these measured differences.

The UK, APU analysis showed that gender differences in performance were related largely to differences in *'opportunity to learn'* for boys and girls. Boys having greater access to science-related experiences outside of school than girls or at least to those experiences typically associated with, and valued in, school science. Links between out-of-school experience and boys' superior performance were found for: physics tasks particularly those concerned with electricity; use of certain measuring instruments and associated units; and tasks requiring certain spatial abilities particularly visualising 3-D figures (Murphy 1991). Hence how a test domain is defined critically effects group performance and the selection of assessment tasks is clearly a source of potential invalidity. The different experiences of pupils was found to affect not only the skills and knowledge they develop but also their understanding

of when and where their knowledge could be used. For example using typically 'masculine' content, e.g. car spare parts, in a task assessing a specific skill or process can depress some girls' performance. Overtly 'feminine' content will similarly disadvantage some boys irrespective of the actual demand of the task. These content effects arise from the combination of avoidance by some students, and the heightened confidence of others. The dilemma for assessors is that such items are sources of assessment invalidity as they measure differences in experience and learnt expectations not achievement which need to be eradicated for summative assessment purposes. On the other hand, they provide teachers with invaluable formative insights to aid curriculum planning. Hence how we view and treat performance differences will depend on our purposes as assessors. This brings into question the feasibility of a single system serving the dual purposes of formative nd summative assessment.

The overt setting of tasks i.e. *the context* was also found to influence performance. Typically girls tend to value the circumstances that activities are presented in and consider they give meaning to the task. The converse is the case for boys. In general in science the effect is to depress girls' overall performance irespective of their actual scientific achievement. The different purposes that girls and boys are encouraged to pay attention to outside of school alter their perception of what is relevant in the same task. The APU results indicated that girls' purposes were more often at odds with those of science assessors than boys and their performance more frequently underestimated as a consequence.

The *mode of measurement* used affected group performance. There is a considerable body of evidence that multiple-choice items advantage males. There appears to be two possible explanations for this. One explanation is cognitive and relates to females' tendency to have a broader view of relevance than males. They are therefore, more likely to see ambiguity in the responses offered. The other explanation is affective and relates to characteristic differences in males' and females' responses to tasks. The evidence here is that females more than males opt for the 'don't know' option or fail to respond to such items. This is explained by the difference in confidence levels of males and females.SCores for females therefore

either misrepresent their actual scientific understanding or measure affective rather than cognitive effects.

Design and Technology: The first UK APU Design and Technology population survey was conducted in 1988-89 for 15-year olds. The results corroborated the earlier science findings about the nature and source of gender differences (Kimbell et al 1991). For example girls were better at identifying tasks, investigating and appraising ideas than boys, whilst boys were better than girls at generalising and developing ideas. Boys outperform girls in modelling whereas girls dramatically outperform boys on evaluating products. The difference in performance on evaluating products is such that low-ability girls (by exam entrance) nearly outperform high-ability boys. Girls outperformed boys in contexts concerned with people whereas boys did better in industrial contexts which mirrors the science findings.

Analysis of pupils' performance on the evaluation component revealed that 'the gender groups prioritise different aspects of evaluation - the boys always referring to manufacture, the girls only when it is obviously required - but that once the aspects are identified the girls are very much better at it' (p 214). Boys were found to be more able to 'get to grips' with reflective aspects of capability when they were practically engaged with developing a solution. Girls were better able to emphasise with users and identify the critical issues without the 'benefit of practical engagement'. Boys were more familiar than girls with concept ideas related to structures and appropriate use of materials and energy systems. Girls typically focused on aesthetic variables in problem-solving activities in contrast to boys. The Design and Technology surveys found that markers were influenced by their view of a 'typical' boy's response, or a 'typical CDT' response. In the main survey, blind marking was carried out. The team commented: "there is some evidence that women mark girls' work higher and men mark boys' work higher. For example, 95% of all female markers mark girls' work higher than their male marking partner" (*op,cit* pg. 134). "We believe they (the female assessors) were simply more in tune with the

typical value positions and approaches associated with girls' work. Exactly the same comment applies to male markers and boys' work" (*op,cit* pp 154).

The APU surveys of science and design and technology found that consistent differences between the performance of boys and girls were due to sub-effects related to the items and/or their administration. The overall difference depends on the combination of effects within the item and the test instrument. The selection of assessment items is critical in developing a fair assessment. Altering the characteristics of items can effect group differences by advantaging one group but in so doing another group would be disadvantaged. This follows because what is being measured up to a point are learnt gendered behaviours and/or expectations.

Policy initiatives

National Assessment (England): The research findings impinged in general ways on the development of standard tasks for national assesment. The face and content validity of tasks was prioritised to ensure 'fairness'. The assessment procedures were designed to enable pupils to exhibit their 'best' performance. Consequently the tasks for 7 year olds were **multi-mode, highly interactive, practically** resourced and with **a limited dependence on verbal and written responses** i.e. the pupil friendly item characteristics established by the APU research. The selection of content and context in the tasks was necessarily restricted. Attempts were made to ensure they were in the experience of most pupils and items were subject to sensitivity reviews. At age 14 the modes of response were less varied and there was greater dependence on written outcomes.

The pilot evidence for science found that for both teacher assessment and standard tasks girls performed mostly in the middle range of achievement whilst boys tended to achieve the extremes. More boys than girls achieved the higher levels. In some cases teachers rated girls more highly than boys in Biology and boys more highly than girls in Physical Sciences. There was a tendency for girls overall to receive higher teacher ratings than boys. The sources of potential invalidity identified included: the shift in meaning of a task from one group to another; variations in teachers' interpretations of the same criterion for different pupils; and teachers' lack of

familiarity with the subject leading to global assessments which might over or underestimate performance. (There was no assumption that performance should be equal between groups (SEAC 1991)).

In the first national science testing no overall gender differences at age 7 were found and more girls than boys achieved the middle ranges. The results showed low levels of agreement between teacher assessment and standard task assessment particularly in science. At age 14 girls just outperformed boys overall but this only reached significance on a few aspects of the science curriculum. Girls were also rated slightly higher than boys in teacher assessments. In Design and Technology girls outperformed boys on the standard tasks overall and on all aspects of the curriculum tested. The same was largely the case for teacher assessment. As with the English tests girls were more highly represented at the higher levels of attainment, boys more highly represented at the lower levels. This pattern was also evident in teachers' assessments (CATS 1991). The summary report of the assessment at age 14 concluded that in all subjects girls were attaining higher levels than boys.

Teachers of 7 year olds were very concerned about the manageability and overall validity of national assessment. To address concerns about differential performance the following issues needed consideration: the lack of correspondence between teacher and standard assessment; pupils' perceptions of the content, context and purpose of tasks; and the differential score distributions for girls and boys in both forms of assessment (both assessments were marked by teachers of the children hence the real potential for assessment bias. The evaluations studies of national assessment confirmed gender differences in favour of girls and reported that a fifth of teachers considered the standard tasks disadvantaged some pupils. There was however next to no exploration of the differential performance. In spite of this lack of evidence the government insisted on radical changes to the standard tasks that ran counter to all research findings about equity in assessment. Consequently teacher assessment was devalued and rendered insignificant; multi-mode tasks and practical contexts were rejected; and written responses became the norm at age 7. At age 14 the standard tasks were replaced by short, written, timed tests. The media, teachers' unions and

professional groups, as well as the Schools Examinations and Assessment Council commented on the potential detrimental effect of the changes on girls' and ethnic and racial group performance but to no avail. Teachers' unions therefore recommended boycotting testing at age 14 and legal action against them this far has been unsuccessful.

Examinations at 16 plus (GCSE): When continuous assessment was introduced in England in the GCSE in 1988 it was hypothesised that it would differentially effect the performance of girls relative to boys when the coursework was written and done outside of class time. To an extent this hypothesis was borne out in exam results but there were exceptions between schools, examination centres and syllabuses (Stobart et al 1992). Nevertheless this view of girls' advantage was widely believed and influenced government policy which sought to dramatically decrease the contribution of coursework to the overall score - which is the present position. However widespread concern about the changes led to the funding of research into exam performance in maths (where boys at 16 outperform girls) and English (where girls outperform boys). The researchers defined a 'fair' examination as one that does justice to the subject and gives pupils opportunities to show what they know, understand and can do. In practical terms this meant offering content and skill requirements and a range of assessment techniques which allow both boys and girls to demonstrate their attainment (*op,cit*). Equal group performance was not presumed.

The project findings showed that coursework did not advantage one group more than another and that it was the exam paper that was the most powerful discriminator. Nor was there any evidence that girls were disadvantaged by the exam component although their teachers believed this to be the case. The research did show that English syllabuses emphasised those aspects where girls typically do better than boys in both the examination and coursework components. There was also some indication that teachers' assessments were influenced by style which disadvantaged boys. Where constructs were not clearly emphasised in marking schemes the potential for misrepresentation of pupils' achievements and the dominance of assessors' beliefs was increased.

In maths both pupils and teachers share a belief in girls' lack of confidence in mathematics. Consequently in the maths GCSE, which is differentiated by entry more girls were entered for the intermediate tier (30,443 more females than males in 1991) and fewer girls than boys entered for the higher tier. More boys than girls were not entered for the exam. Hence the tendency to view boys as achieving extremes and girls as achieving in the middle ranges is prejudged by teachers largely on the basis of affective rather then cognitive differences between pupils. The intermediate tier, for example, was seen as 'safer' for girls who fear failure; and the non-entry of males into the lowest tier was argued on the basis of the potential demotivating effect which teachers believed was more marked for boys than for girls. The research revealed that teaching practices such as setting might be adding to girls' disadvantage in maths. They also noted that boys were unperturbed by their lack of success in English which reflected their view and teachers of the subject's low status. What was particularly noteworthy in the research findings was the almost complete lack of awareness of gender differences in performance and attitudes demonstrated by teachers and perhaps more worrying, by examiners who conduct the sensitivity reviews. Unfortunately little evidence about individual item performance or effects of methods of measurement on construct validity was provided by the project which had to research and report finding within the short time span of ten months.

Discussion: Recent UK policy initiatives in assessment indicate a retreat away from the new paradigm of educational assessment. A retreat fuelled by beliefs that such assessments advantage some groups more than others and that continuous assessment has less reliability and validity than examinations. These beliefs conflict with previous and present research into sources of differential performance and are based on inadequate conceptions of equity in terms of equal outcomes. Yet there remain significant gender difference in entry patterns and outcome in examination at 16 plus and 18. In 1990 girls accounted for 29.2% of Physics entrants at 16 plus and in 1992 over 3 times as many boys as girls took Physics 'A' level. The underrepresentation of girls is less marked in Chemistry but nevertheless significant. In Biology where female entrants outnumber males boys outperform girls at both GCSE and 'A' level. Such a national picture does not encourage complacency. Nor until there is a better

understanding of how the construction of assessments differentially effects groups will assessment promote equity in education. It will be of considerable interest to see how the USA pilot model of national assessment develops given that it shares many of the goals and political dilemmas inherent in the UK model.

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IN A DIFFERENT VOICE: EMPOWERING FEMALE ELEMENTARY TEACHERS IN SCIENCE

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Chaque fois qu'on aborde la question de l'enseignement inadéquat des sciences, les enseignantes et enseignants des écoles élémentaires reçoivent la majorité des critiques. Étant donné que le personnel enseignant des écoles élémentaires est composé en grande partie de femmes, il est essentiel de réexaminer cette question d'un point de vue féministe. On pourrait commencer par envisager de blâmer l'enseignement des sciences pour les femmes plutôt que la victime. Un tel point de vue exige une approche nouvelle à la formation scientifique préalable des enseignantes et enseignants. On pourrait offrir une différente vue des connaissances scientifiques en inculquant aux femmes la nature de la construction des connaissances scientifiques et en les poussant à s'imaginer elles-mêmes dans des rôles d'enseignante-chercheuse et d'enseignante-apprenante chevronnée. En offrant aux enseignantes en formation préalable la possibilité de considérer la construction des connaissances scientifiques sous un angle différent, on leur permet aussi de s'exprimer.

Dans ce document, nous allons tenter de décrire le récit de trois enseignantes en formation préalable d'école élémentaire qui envisagent de changer les attitudes ancrées. Deux de ces femmes, des enseignantes en formation préalable d'école élémentaire, ont envisagé une vue constructiviste des connaissances scientifiques en tant que moyen d'expression dans le domaine de l'enseignement des sciences dans les écoles élémentaires. La troisième femme est professeure de sciences. Elle tente de promouvoir le processus de prise de pouvoir des enseignantes dans le domaine des sciences.

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IN A DIFFERENT VOICE: EMPOWERING FEMALE ELEMENTARY TEACHERS IN SCIENCE

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ABSTRACT

Whenever the issue of inadequate instruction in science is discussed elementary teachers receive a major portion of the criticism, and such criticism has added to elementary teachers viewing themselves as deficient. Since the majority of elementary teachers are female we need to reconsider this issue from a feminist perspective. An alternate vision would be the viewing of the science education of women as being deficient rather than blaming the victim. Such a position calls for a different approach in teaching preservice elementary science education. One approach is to offer a different view of scientific knowledge which involves preservice women in understanding the nature of the construction of scientific knowledge and the envisioning of themselves in such roles as teacher as researcher, and teacher as experienced learner. By giving preservice teachers the opportunity to view the construction scientific knowledge differently it allows an opportunity for a voice.

In this paper we will attempt to describe the stories of three women involved in preservice elementary education who are beginning to construct a new framework. Two of the women are preservice teachers in elementary education who have begun to examine a constructivist view of scientific knowledge as an avenue for bringing their own voice to elementary science instruction. The other is a science education professor is attempting to facilitate the process of empowering female elementary teachers in science.

A Constructivist Approach to Empowering Female Elementary Teachers in Science

Traditionally female elementary teachers perceive of themselves as being deficient in science and have been taught to assume the fault is theirs. The result is they are reticent to look externally for the cause of the problem. Therefore the viewing of science from a constructivist perspective allows female elementary teachers to become active participants in bringing about instructional changes in elementary science teaching. Within the constructivist framework the social construction of scientific knowledge is a particularly useful analytical framework. This position is that scientific knowledge is socially constructed rather than that there is an objective reality to be discovered. Beyond that claim feminist theory even extends the argument further to entertain the idea of the social construction of science and gender.

In particular, Keller (1985) argues that not only are science and gender socially constructed but that science has socially been constructed in a masculine image. Feminist theory however is characterized by some commitment both to critique, and to a project for change (Noddings, 1990).

Feminist scholars have always expressed an interest in examining the gender and science question (Harding, 1986; Tuana, 1989). Often the focus of such examinations tends to be on the stories which describe the patterns of successful women in science. Such models have provided researchers with such research which we are now attempting to employ in intervention projects with young women. While one can see the merits of such research we are still at a lost when confronted with the adult female. The question is what strategies can we employ in the science education of adult women in preservice/inservice programs? We need to examine the profiles of female elementary teachers who become interested in science because their voices need to be heard.

More Than One Voice

The Argument

If we view of the science education of women as being deficient rather than blaming the victim this calls for a different approach in teaching preservice elementary science education (Bearlin, 1990). One approach is to offer a different view of scientific knowledge which involves preservice women in understanding the nature of the construction of scientific knowledge and the envisioning of themselves as teacher as researcher, and experienced learner. This allows the opportunity for a voice.

Post-modern feminists (Nicholson, 1990) pose a further question about gender and science. They ask who are the women we are talking about? Women are not homogeneous. We differ by such factors as class, race, culture, and sexual orientation. This suggests that multiple feminists voices (Belenky et al, 1986) be heard not a dominant feminist voice (white, Western, academic).

The employment of a feminist agenda carries with it a responsibility for transformative action (Noddings, 1990). A part of what transformative research is about is empowerment by gaining an understanding about the forces that are acting to shape our lives. The next step would be to take action.

Empowerment is viewed as being achieved when the actors are able to change their situation. We will describe the stories of three women involved in preservice elementary education who are beginning to construct a framework which empowers the elementary female teacher to teach science. Two of the women are preservice teachers and one is an assistant professor. In our collaborative efforts we have employed a feminist methodology

Cathy's Story - An Emerging Elementary Science Teacher

When I think about my lack of background in Science I feel shortchanged. There is nothing in my early background which came even remotely close to exposing me to anything scientific. This lack often keeps me from having faith in my ability to figure out a problem. For instance, when an appliance doesn't work properly or a new toy needs to be put together, I immediately turn to my husband to take care of it. Traditional roles exist in our marriage along with the gains we have achieved in going beyond these roles. They are traditional in the sense of the male being more inclined to be the mathematical one--he is an engineer, while for me, the female, is one of being more nurturing--the care giver. Sometimes the roles overlap, but more often not.

I grew up in a very traditional household. It is hard to break out of patterns and roles, although it took quite a few breaking out of roles to get where I'm at. I come from a family of 13 children, five sisters and seven brothers. I am sixth in the lineup of children--a middle child. My parents hadn't the time to encourage me nor the money. Many forces were at work which deprived me of a background in science as well as other important areas. The schools I went to, the Catholic religion I was brought up in, my family's economic, social standing and the role models I had when I was younger all combined to keep the seed of innate curiosity and talent dormant.

The grade school I went to was Catholic. Most of the families were blue collar workers and had little money. Consequently, the school had little funds to work with. I'm not sure if that's why science was not included in the curriculum or if it was just considered irrelevant. Whatever the case, I had no formal schooling in Science during my elementary school years. The high school I attended was also Catholic. These were opportunities to pursue science here, but the traditional role model I grew up with allowed little room to

entertain the possibility of taking such a difficult (male) subject. Taking science or advanced math wasn't even in the realm of my thinking at the time.

All of my younger years prepared me to be a mother, a wife; one who stays home and takes care of others. Any attempts to break out of this role were squashed either covertly or overtly. A double standard existed in our family--one set of rules for the boys and another for the girls. The boys were allowed much more freedom than were the girls--freedom to be out later, freedom to go more places, freedom to explore and freedom to be curious and test that curiosity. My brothers were encouraged to tinker and explore life while my sisters and I were not allowed this same freedom.

Because of my economic social standing there were many things I was not exposed to that others take for granted. For instance, I was not exposed to music in any form. There were no role models and no opportunities to experience music. During my primary years, I did not have access to books other than school textbooks. Later when I was old enough to go on my own, my sister and I would go to the city library for books. No role models existed for attending college. My sister contemplating college was discouraged by my father saying, he might be able to come up with the money somehow if my brother wanted to go, but girls don't need college; they just get married. Finishing high school was my goal during my teenage years. College was for others not me. I wanted to end the drudgery of studying and earn some money for my own. College therefore was not even a thought in my mind.

The area of the country, in the Midwest and in this generation, women were supposed to act and dress a certain way. Women (and girls) still wore dresses. I can remember the uproar when girls were allowed to wear slacks to the public schools. As I was attending a parochial school, we continued to wear our uniform skirts.

Catholicism heavily influenced my life. One was to follow and obey rules without question--a blind faith. There were strictly defined roles for women at this time and entertaining the idea of studying science didn't even exist. As I was taught not to question, I never really thought much about my existence as a child. I did what I was told and did not think beyond that. Critical thinking,

that which is desired for scientific thinking, didn't exist for me during those early years.

Eventually I began to question and wish for more. Working in the clerical field after high school for five years I began to think about college. I saw it as a way out of the mundane life I was experiencing. It was the beginning of a new life for me. This is the background I come to teaching with. Over the course of the past years I have broadened my life considerably and filled in many of the wide gaps of knowledge that existed. Teaching science will be a challenge for me initially. There is so much that needs to be experienced and learned. However, the upside of this is the attitude towards teaching Science that I gained through Preservice Methods Science Class. Here I learned that it's okay to learn along with the students. It's okay to not know all the answers. And more importantly, I am not just a transmitter of knowledge into an empty vessel, called a student. I am a facilitator on a journey with students who bring a set of ideas and knowledge with them to the classroom and together we explore science. My natural curiosity and enthusiasm about how life works will prompt me to learn more along with my students in science. There may always be a hesitancy on my part with tackling the new in science studies, but it is my goal to go beyond this hesitancy and expose students, females as well as males, to the wonderment of science whenever possible.

Blanca's Story - An Emerging Bilingual Elementary Teacher

When I was eight years old my parents decided to come and live in the United States of America. I had lived in Mexico all my life. I remember when I was six years old I had come to the United States as a tourist. I stayed here for two weeks, and I was so lost. People talked a language that was so foreign to me. I didn't understand a word so when we went back I was so happy to be home again. It had never crossed my mind that some day I would be living in the country that made me feel so foreign. When I first arrived here every thing was so different but it was okay because it was summer vacation, all I did was explore my new world and my mother, or my father, or my two brothers, or my sister were always around to assure me that I wasn't alone in this new, strange country. All these good feelings that my parents and my two brothers

and my sister had given me about this new country during the first month that I was here disappeared that first day I went to school.

I never really sat down to think about the things I've been through in this country as an immigrant until I entered the Bilingual Education Multiple Subject Credential Program at San Jose State. During my first semester siting in my classes and listening to some of my classmates talk about things they learned in elementary school; some of their experiences I realized that I didn't have any memories of my elementary school years here in the United States. I remembered my junior and senior high school years but not my elementary school years. It was almost list it didn't exist. I then decided to sit down and think about the things I learned in elementary school and the kinds of experiences I had. After sitting down for a while I realized why I didn't remember anything pleasant about those three years and everything I did remember about those three long years brought tears to my eyes. I don't remember anything but English, and I remember feeling like an alien in a classroom where I was called a "wet back", and probably other names that at the time I didn't understand. Reading Olsen's *Crossing the Schoolhouse Border--Immigrant Students and the California Public schools* brought even more sad and cruel memories back and it made me realize that I'm not the only one who feels this way. In addition to facing academic frustration, Olsen notes these immigrant students also experience harassment, intimidation, and violence against them. My question is how can any student learn under these conditions?

One of the most important reasons why I decided to become a bilingual teacher was to help children not feel as lost as I felt when I started going to school in this country. After entering the program I realized that the most important reason is to try to make a change in our school systems. Students have to learn to respect other students and most important of all they have to learn to value and respect their own and other cultures.

I have not decided on a specific model for teaching science yet. But, I know that science is going to be taught, of course using all the great techniques I have learned in this program to enhance my teaching. One very important thing that I've learned is that in my bilingual classroom where I'm probably

going to have a diversity of ethic students in different academic levels I need to have lots and lots of visuals, and I have to use as many manipulatives as I can. Perez & Torres-Guzman (1992) present lots of great methods to use in classrooms where you have a great diversity of students. A great method is theme teaching and dividing these themes into sub-themes to help guide the students development. When students are doing science they are using the process that scientists use - they hypothesize, or connect ideas, they gather data, they look for confirmation of their ideas, and they reach conclusions that may lead them in new directions (Perez & Torres-Guzman, 1992). Using the theme, sub-theme method the students can work in a research fashion like scientists and a teacher's role is to direct the activities without formulating them, or expecting specific results. The teacher also has to maintain interest through research procedures, model building and generating, testing hypotheses, and bringing up areas of contrast and conflict. This method to me seems ideal right now. I am going to try to teach science in this thematic way but, with a lot of modeling and example. In this way students are exposed to the English language and the learning of science.

Everything I learned in science methods is going to be very valuable to me in my teaching career because like I said before, I didn't learn anything but English during my elementary schooling. One of the most important things I learned about science teaching is that model building and generating is very important because there is so much to be learned from building a model even if it doesn't work. Because then students can explore the reasons why it didn't work and a lot of learning takes place during this process. Another important thing that I have learned about the teaching of science is if the teacher brings up areas of conflict and contrast this makes the students think and explore.

Sharon's Response: Call for a New Vision

Briefly, before I respond to Cathy and Blanca I would like the reader to know that I teach an elementary science education course to fifth year education students. The students are required to do a two hour course as part of their requirement for certification as an elementary teacher. My students who are mostly female, and they come from very diverse social, ethnic and racial backgrounds.

While there are a number of scenarios that are worth examining in the two stories I will focus on the dominant theme of each. Cathy is a non-traditional education student enrolled in the elementary teacher education program. As a result of my attempt to listen to Cathy's voice I would describe her as an emerging elementary science teacher. It is both her maturity and her experience as a mother that gives her confidence to now try science. Although her success with teaching science to elementary students is yet to be determined there are indicators that she may go beyond the token effort. Since finishing my course she has successfully completed student teaching and she has also presented a workshop at a state science teachers conference.

Blanca's story is quite different, and is one that I came face to face with when I read her position paper, at the end of the course. At the end of the semester I often get caught up in the reading my students position papers in which they envision themselves as future teachers of elementary science. Their visions are so promising. There are so many good pieces that I want to cut out and share with future teachers. Beyond the good things to share there is a constant theme which appears in their writing quite often - initial fear and dislike of science, bad past experiences; some claim to recently see things differently, as in Cathy's story. Blanca's story was different in that there was this extra struggle because she was a immigrant who didn't speak English; beyond that she had to cope with racial discrimination. I immediately realized her story was one of building confidence and that it was the multicultural elementary education program which would have the greatest impact on her view of science teaching. Blanca is now finishing her course work before she does student teaching.

I go away from reading Cathy's and Blanca's stories feeling that some how I have let them down because there needs to be follow up. We need to provide further opportunities for growth as they begin their teaching career. One step forward to enriching the science experience of elementary school teachers is to establish a formal 'bridge' between them and the universities they graduate from. The universities' responsibility for the science education of teachers should not stop when they graduate. It is when they begin to teach that the task of learning to teach really begins. Beginning elementary teachers need

continued access to scientists, science educators, and other mentors. We need to establish this bridge. The bridge should consist of both college and school district personnel who are committed to helping novice teachers in science begin their professional careers.

Our research also suggests that we need to challenge the nature of the elementary science education program which is available. The need is critical, especially in the education of female elementary teachers who have already been victimized by a poor education in science. One outcome of our collaborative sharing is to question the future direction of elementary science education for females. Given that our research has been influenced by constructivism and feminist theory we certainly sense the need to examine the nature of science education with a focus on how can we develop a new vision for the science education of prospective elementary teachers. The two stories described suggests this might be possible by bringing a feminist interpretation of a constructivists approach to elementary science education. The question that we would like to pose is what are the stories of other women. If their stories are as interesting as ours then we need to look further. We must not only assume an agenda of what is good for science but an agenda of what is good for all women.

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Talking Girls Out of Science

Heather Ryan

Cette étude de cas naturaliste tente d'établir l'existence de différences notables entre les expériences en classe de sciences des filles et des garçons, visibles dans les interactions orales. Les interactions dans les classes de sciences ont été prises en note sur papier et enregistrées sur bande vidéo dans deux classes de 8e année d'une région rurale de l'Alberta, pendant cinq semaines. La personne responsable de l'étude a dressé un inventaire des comportements verbaux, adapté de Kelly (1955). Les échanges verbaux considérés comme pertinents à l'intérêt, à l'assurance et à l'accomplissement ont été comptés, après analyse de deux segments sélectionnés au hasard de la bande vidéo de chaque classe de jour. Le résumé de l'inventaire des comportements verbaux offre un échantillonnage comparatif des principales formes de discours des filles, des garçons ou de l'enseignante ou enseignant dans chaque classe. Parmi les variables majeures, notons les louanges, le contrôle du temps, l'allocation des ressources aux étudiantes et étudiants et le caractère émotionnel, important pour remettre les évaluations et assurer un certain contrôle. On a tenu compte de la différence des sexes en ce qui concerne le concept de soi, les diverses approches à la résolution des problèmes ou les accomplissements, en administrant quatre instruments; analysés par le *test bidirectionnel Anova*. *LPQ* (Mulcahy, 1987) a évalué les motifs et stratégies d'apprentissage. Aucune différence importante, par sexe ou par classe, n'a été établie en ce qui concerne l'approche de surface à la résolution des problèmes (court terme, axé sur les notes), mais un effet important (F=0,004**) a été établi en ce qui a trait à l'approche plus approfondie et compétitive (tant la compréhension que la maîtrise), la deuxième classe ayant obtenu de meilleurs résultats. *PPSI* (Mulcahy, 1990) a mesuré les compétences personnelles perçues, ainsi que la planification et le contrôle. On a relevé une différence significative (F=0,18*, df=1) en faveur des hommes en ce qui concerne les compétences personnelles perçues. Les moyennes pour le contrôle personnel étaient de 3,16 pour la première classe et de 3,29 pour la deuxième classe. *OLMAT* (Psych. Corp, 1967) a mesuré le raisonnement; la connaissance des sciences a été mesurée par *TASK* (Stanford, 1982); aucune différence importante n'a été établie. On trouvera plus loin quelques suggestions sur la façon d'accroître la participation des filles et d'améliorer leurs accomplissements dans des cadres similaires.

Talking Girls Out of Science

Heather Ryan

University of Alberta

This naturalistic case study sought to determine if there were observable differences in science class experience for boys and girls, recognizable in the language shared. Science class interactions were recorded in notes and videotape in two rural grade eight classrooms in Alberta for five weeks. The researcher devised a verbal behaviour inventory (VBI), adapted from Kelly (1955). Verbal exchanges identified as relevant to interest, self-confidence and achievement were counted, based on analysis of two randomly selected segments of videotape of each day's class. The VBI Summary provides a comparative sampling of the major forms of talk by girl, boy or teacher in each class. Major variables were praise, control of time, allocation of resources to students, and emotionality, significant in transmitting appraisals and providing control.

Consideration of gender differences in self concept, problem solving approach, or achievement was by administration of four instruments; analyzed by *Anova 2 way test*. *LPQ* (Mulcahy,1987) assessed learning motives and strategies; finding no significant difference by gender or class on surface approach to problem solving (short-term, marks oriented), but significant effect (F=.004**) on deep and achieving approach (both understanding and mastery focus) with class two scoring higher. *PPSI* (Mulcahy, 1990) measured perceived personal competence, planning and control. Significant difference (F=.018*, df=1,) favoured males in perceived personal competence. Means on personal control were 3.16 for class one; 3.29 for class two. *OLMAT* (Psych. Corp, 1967) measured reasoning; science knowledge was measured by *TASK* (Stanford, 1982); neither found significant difference. Suggestions follow for improving girls' involvement and achievement within similar settings.

Much has been written about the unintended suffering that children encounter from their parents. Evidence from worldwide research suggests that science teachers, with the best of intentions, also wound young girls, whose futures in studying and practising science are impeded by the language used in their junior high classrooms. Research suggests implicit messages concerning gender and power relations are communicated between teachers and students, resulting in differentiated experience in science studies/achievement and an alienation of females from the field. My research suggests the impact of this exclusion is social as well as personal. Jacknicke and

Rowell (1984) also claim that the current technical approach to science education separates the learner from the process of science. It is my view that this approach is both a language and a method of teaching. The girl student may, my study indicates, be particularly alienated by this systematic approach.

Tobin, Kahle, and Fraser (1990), Lemke (1990), and my own science teaching experience also suggest that the separation of student from teacher according to expertise in curricular content alienates students from class involvement and provides teacher control. Fensham (1988) observed that girls' cultural codes divert them away from science in spite of talents and interests. Harding (1986) observed the competitive nature of traditional science classes was antagonistic to the cooperative, shared learning preference identified in girls. Peer group pressure against being seen as bright or cooperative with the teacher reinforced the internalized social norms, impacting more negatively on girls.

Further to the work by White (1986), Linn and Hyde (1989) and Erickson and Erickson (1984) found that gender differences in cognitive skills have declined; those that remain are largely explained by experiential difference. Powerful support for a cultural explanation for sex differences in motivation toward science can also be drawn from Steinkamp and Maehr's (1984) comparisons of data by country. Comparing the position of women in society and the orientation of girls in each country, they found that girls' orientation may be a function of attitudes toward women. The social climate may be more important than social action policy: although mass education and anti-discrimination laws are found in the U.S. and New Zealand, only 22% and 14% of their youth believed in equal rights for women. Sex differences in science performance/interest were found to be most pronounced at age thirteen and increasing in recent years. Discriminatory science marking practices may also contribute to differential performance; Spear (1987) found boys received higher marks than girls for identical work (p. 50).

The technical approach that Jacknicke and Rowell (1984) describe is perhaps best seen in the language conveying meaning in the classroom. It is my view that this language is responsible for many of the observed disparities in experience, interest and achievement of girls in science classes.

GASAT Conference proceedings (1986) described a relative decline in girls' achievement, interest and enrolment in science during the early years of secondary education, in relation to boys as well as the girls' earlier performance. Gendered differences in classroom experience may be considered to have career and social impact. Males in the U.S., in the last two decades have had greater access to science careers and greater earning power (National Science Board; 1987). Enrolment of teenage girls in classes other than maths or science denies them prerequisites for later science study (Harding, 1986; Kahle, 1987; Erickson & Erickson (1984).

A method of demonstrating my claim is available in Kelly's Personal Construct Theory (1955). Kelly proposed that each person uses language constructs to join unfamiliar information about the world to what he or she already understands. Given the popularity of this Vygotskian view today, it seems evident that language both lures the learner and eventually symbolizes the material learned. The neo-Vygotskian educator, Cazden (1988) identifies the benefits of discourse "as catalyst, as the enactment of complementary roles, as relationship with an audience, and as exploratory talk instead of final draft"(p.126).

NATURE OF THE STUDY

This naturalistic case study sought to determine if there were observable differences in science class experience for boys and girls, recognizable in the language shared. Science class language/interactions were observed and videotaped in two rural grade eight classrooms in central Alberta for a period of five weeks. Each school contained one class of K-12.

Class 1 designates a grade eight science class, with 9 boys and 15 girls, instructed by a highly respected male maths teacher, 2 years from retirement. Class 2 designates the collective of 13 girls and 16 boys, taught by a Biology major in his forties. The researcher devised a verbal behaviour inventory (VBI), adapted from Kelly (1955), and based on two randomly selected segments of videotape of each day's class recorded verbal exchanges identified as promoting interest, self-confidence and achievement in science classes.

The classroom VBI summary provides a comparative, sampling of the major forms of talk by girl, boy or teacher in each classroom, and the relative frequency of relevant verbal behaviours.

Major variables considered were praise, control of time, allocation of resources to students, and emotionality: significant in transmitting appraisals of students and providing control (Kenway & Willis, 1990). A model for the study of classroom teaching (Shulman, 1990) provided precise areas to be investigated. Fieldnotes were kept in each class to give a sense of class environment as well as factors that may influence interpretation of videotapes.

Potential gender differences in personal control and perceived self-confidence were tested by comparing performances of students on the *Perceived Problem Solving Inventory* (*PPSI*; Mulcahy, 1990). Motives and strategies for learning, distinguished as either Surface (for short-term mastery and grade achievement) or Deep (based on intrinsic desire and strategies for both understanding and mastery) were measured on the *Learning Process Questionaire* (*LPQ*; adapted from Biggs, 1987). Perceived self-confidence (*PPSI*; Mulcahy, 1990) was compared to reasoning ability on the *Otis-Lennon Mental Ability Test (OLMAT;* Psych. Corp., 1967) and general science knowledge of the *Stanford Level 1 Science Subtest* (*TASK*). A brief written interview was completed by the cooperating teachers to share their feelings and suggestions about the experience.

The results of the *OLMAT* and *Stanford Science Achievement Test* were submitted to a t-Test to determine if there was significant difference in performance between girls and boys. An accurate description of the climate and interactions in each class was provided from the daily observations in field notes and videotapes and by the VBI summaries.

The study was guided by four assumptions. The critical researcher must question not only the content and the mode of presentation of school science, but also the intent of those who decide content. Preconceived values and assumptions about men and women and their place in the world are the root metaphors currently influencing many science classrooms. Conjectured biological or cognitive differences can not adequately explain differences in attitudes, interest and achievement nor direct possible solutions. Questions raised by this case study about observed social order and science performance, hopefully may encourage educators to identify their own and students' differential use of language and promote redress of gender inequities.

NATURE OF THE DISCOURSE: CLASS 1.

Teacher 1 generally used assertive, often demanding language, and emphasized technical terms with high voice volume. Only once was the teacher asked a question by a girl and twice by a boy (item 7 VBI). High focus on control was observed to contribute to a climate of standardization and predictability, typical of traditional science classes. Stereotyping comments by this teacher were identified on three occasions (item 13).

Questions demanding application or detailed adaptation of knowledge or promoting interest in the topic were asked four times by Teacher 1 of the whole class, and twice to boys only. Twice boys directed a challenging question to their teacher.

VBI item 11 (participation in or encouragement of peer group learning or joint problem solving) was engaged in once by Teacher 1; four times girls encouraged other girls; and twice a girl encouraged a boy to work with her. Boys and girls were polite, hesitant to ask questions of the teacher or each other, until they had visible teacher approval.

The teacher criticized girls eleven times, boys three times, the whole class three times; a boy criticized a girl once, another boy once; and four times a girl criticized another girl (item 4). Correcting others' behaviour (item 5) was similar. Twice the teacher corrected the whole class; twelve times he corrected girls, eleven times boys; twice a boy corrected another boy and once a girl.

Although students did not use the formal language of science in discussion, it was attempted frequently in answering questions. On no occasion was encouragement given by teacher or students for out of class activity related to science (item 12); nor was science discussed as important to career or lifestyle (item 10). The five boys and two girls most frequently asked questions by Teacher 1 were outgoing and high achievers on instruments in this study and in the perception of the teacher. Greater interest of girls in working together was apparent in their seating arrangements during labs and informal discussion, and in their greater involvement in advising each other (# 6) or encouraging one another(# 11).

NATURE OF THE DISCOURSE: CLASS 2.

The language used by Teacher 2 invited questions and dialogue, and used everyday examples and expressions to relate scientific terminology (item 12). He related science curriculum to everyday life or social issues on seven occasions (item 14) and encouraged problem-solving students to offer ideas in unfinished or first draft form. Large numbers of students volunteered insights and used formal language, including two boys clearly at a disadvantage in understanding the curriculum as shown by their off-target answers and their poor performance on *OLMAT* and *TASK*. Teacher 2 directed his criticisms to groups or behaviours rather than to individuals.

Stereotyping comments were offered once, by a boy. On several occasions Teacher 2 quieted dominant students and called, instead, on reserved girls. Challenging questions were asked of the class twelve times and four times by boys. Girls did not ask challenging questions, although the researcher sensed their input was desired by the teacher. Encouragement for cooperative learning or problem solving (VBI item 11) was detected ten times by Teacher 2; four times by girls; and four times by boys .

Nineteen times boys were asked questions by Teacher 2, 12 times for girls. Praise was given by the teacher to boys eight times, to girls three times. Correcting other's answers or behaviour was nine times from teacher to boys; to a girl once. The teacher gave advice to a girl once but six times to boys. Eleven girls manipulated lab apparatus, compared to twenty-six boys.

QUANTATATIVE FINDINGS AND INTERPRETATION

Using the *Scheffe' Post-Hoc Fairwise Contrasts*, no significant gender difference was found in performance on the *OLMAT*. Using a two-way *Anova*, with *Scheffe's Multiple Comparisons of Main Effects* on the *TASK* science achievement results, no statistically significant difference was found by gender or by school. In school 1, boys performed at a higher level (a grade equivalent of 12.4) than the boys in school 2 (grade equivalent of 8.8) and higher than the girls in school 1 (grade equivalent 9.2) or school 2 (grade equivalent 9.4). This disparity in performance may be linked to the impact of two boys who were clearly having difficulty.

That a gender difference in class experience exists was suggested by the greater willingness of boys to voice examples, elaborations, or challenges (items 7 and 8-VBI). Girls were less likely to volunteer elaborations of answers or apply concepts to everyday experience. On the *LPQ*, students in school 2 demonstrated more of a deep approach to learning than in school 1 (F=.004**). However, this is qualified to some extent, by evidence that boys in school 2 displayed greater deep motives for learning than did girls. Basically in class 2, there was no difference in surface approach to learning between boys and girls; while in class 1, the boys showed greater surface motives and strategies than the girls.

Comparing *PPSI* means shows that School 1 boys (2.83 of five) and girls (3.07) use less planning and are less aware of alternate problem solving approaches than School 2 boys (at 3.50) or girls (3.09). The difference in perceived competence of boys (3.85) and girls (3.46) was statistically significant at .018*(df=1); and supports experience and literature conclusions that girls see themselves as less competent in problem solving. A disturbing disparity between an actual strong performance of the girls (*TASK*) and their perception of their competence at problem solving (*PPSI*) became apparent.

CONCLUSIONS

Observation of these classes corroborates the literature. Teachers more often praised boys for understandings and efforts (twice as often, item 3) or to control them (almost twice as many questions asked, item 7); boys did more 'hands on work' during labs and demonstrations (twice as much, item 9) while the girls were recorders or displayers.

It was not clear that boys intended to monopolize the resources. Social norms may have encouraged the girls to let boys be more active in groupwork. Girls, when allowed, would move together to talk, share answers or work on homework. This supports the claim in research literature that girls are more cooperative in science class. Gender inequity was also reflected by the fact that only once did a teacher offer an example of a scientific invention by a woman.

A small number of students, mostly boys, were always ready with answers; when an answer was important to building the lesson, the teachers asked one of this group. These students were

described as top students by the teachers. Some girls stayed minimally engaged and anonymous for much of the classes. In class 1, five such girls were rated by the teacher as at the bottom of the class, although three showed science knowledge on *Task* superior to that of five boys.

IMPLICATIONS FOR CLASSROOM PRACTICE

Because, the science class acts like a mirror reflecting an impression of future science studies and the likelihood of achieving or enjoying science careers, this study suggests: (1) increased efforts to involve girls in class activities; (2) challenges to girls to complete complex activities rather than to let the teacher do them; (3) grouping girls by single gender or with non-dominating boys to increase hands-on experience; (4) encouraging outside readings and science-related activities for girls, (5) engaging girls in informal science talk; (6) Reducing science jargon and sexist language to reduce girls' alienation and boredom. The value of female role models in influencing girls to pursue science studies also deserves research.

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GENDER EQUITY AND COMPUTERS IN CONTEXT

Sandra Acker and Keith Oatley

Les jeunes filles et les femmes sont constamment sous-représentées dans les mathématiques, les sciences et la technologie, tant à l'école que dans les milieux de travail; plus on monte dans l'échelle des professions et plus cette sous-représentation est évidente. Ce document aborde une préoccupation toute particulière, celle des obstacles à la participation dans les secteurs des sciences et de la technologie, y compris l'informatique, et les efforts visant à modifier la situation. Bien qu'il soit largement reconnu qu'un problème existe, sa complexité est parfois sous-estimée. Par exemple, il existe des variations transculturelles dans les modèles de représentation. Expliquer la raison pour laquelle ce problème existe est encore plus difficile. Les explications courantes se fondent souvent sur un modèle socio-psychologique, mettant l'accent sur des facteurs tels que la motivation, les intérêts, l'identité et la confiance en soi des femmes, alors que d'autres jettent le blâme sur les méthodes et pratiques scolaires, qui permettent aux garçons de dominer dans les interactions au sein de la classe et dans les cours d'informàtique, pendant que les filles sont marginalisées. D'autres discussions sortent des murs des écoles pour examiner les pratiques des établissements d'enseignement supérieur et des milieux de travail qui défavorisent les femmes. On a toutefois tenté de remédier aux iniquités en déployant une série d'efforts visant à intervenir au niveau de l'école. Nous vous proposons ici quelques exemples d'une telle intervention, compte tenu du fait qu'il est essentiel de prendre en considération les circonstances réalistes entourant le travail du personnel enseignant et les valeurs concrètes en salle de classe. Pour terminer, nous abordons un certain nombre de questions qui devraient encourager d'autres efforts d'intervention dans l'avenir. Ces questions exigent que nous nous penchions plus en détail sur les théories féministes et autres, sous-jacentes aux efforts d'intervention, les critères qui déterminent le succès, l'à-propos de l'attention que l'on accorde aux divisions sociales autres que le sexe et les façons dont nous pouvons, aussi bien que possible, mettre en rapport et mettre à profit les résultats des projets pour amener un changement durable.

GENDER EQUITY AND COMPUTERS IN CONTEXT

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ABSTRACT

Girls and women remain substantially under-represented in mathematics, science, and technology, both in school and the workplace; this under-representation increases in the progression from the lower grades of school to the higher stages of careers. A particular concern in this paper is obstacles to involvement in science and technology, including computing, and efforts to bring about change. Although it is widely recognized that a problem exists, its complexity is sometimes underestimated. For example, there are cross-cultural variations in patterns of representation. Explaining why the problem exists is even more difficult. Prevailing explanations frequently draw upon a social-psychological model, emphasizing factors such as women's motivation, interests, identity and self-confidence, while another body of literature places the responsibility on school processes and practices whereby boys dominate classroom interaction and computer use while girls are marginalized. Other discussions move outside schools to identify practices in higher education and in the work environment which disadvantage women. The inequities have been challenged, however, by a series of efforts at educational intervention. We discuss examples of such interventions, also considering the need to take account of realistic circumstances of teachers' work and classroom practicalities. In the conclusion, we raise a number of questions which should inform future efforts at intervention. They require us to reflect more deeply on feminist and other theories which underlie intervention efforts, the criteria by which success should be judged, the adequacy of attention to social divisions other than gender, and the ways in which projects' results can best be synthesized and used to accomplish lasting change.

THE PROBLEM

We assume, as do many educators, that mathematics, science and technology form a cluster and that economic prosperity depends in part on developing a community of skills within this cluster. Women are under-represented in these activities, and consequently there is a smaller pool of skilled and qualified people than we would wish. At the same time women do not share equally in the pleasures and benefits

these fields can provide. Why is this so? How might it be changed?

In 1988, for instance, women earned 12.6% of the undergraduate degrees, 12.0% of the master's degrees and 8.6% of the doctorates in engineering and applied sciences, and received 21.5% of the bachelor's degrees in computer science (Statistics Canada, 1990, p. 168-71). As to employment: in 1986 women were 29% of the employed science and technology labour force, compared to their overall labour force participation of 43%. Many of these women are social scientists: architecture, engineering and related fields had 7% women (Statistics Canada, 1989, pp. 27-28).

Although the consensus is that cultural variation is the source of differences between male and female representation in science and technology, there are variations in representation as a function of social class and ethnic differences (Oakes, 1990; Steinkamp & Maehr, 1984). In USA, access to computers in school is relatively restricted for children of low socio-economic status and those from ethnic minorities (Linn, 1985, p. 238), and for girs as compared to boys (Bernhard, 1990).

Chipman and Thomas (1967) show that Black, Hispanic and Native Americans are all underrepresented in higher education in USA; and within each group, as well as within the white majority, women less often take doctoral degrees than men. Overall, sex differences appear in representation: they are "large for engineering, quite large for physical sciences and computer science, and quite small for mathematics and biological science" (Chipman & Thomas, 1987, p. 397). There are similarities in subject specialization of men and women within each ethnic group. Asian American men and women are over-represented in science and technology compared with their representation in the university population as a whole.

THE SEARCH FOR EXPLANATIONS

Although most commentators recognize that explanations of differences in participation must take into account the individual, schooling, and society (Oakes, 1990), the most common framework is social psychological: the assumption is that whatever the influences, in the last analysis a person makes choices. Eccles (1984) frames the decision to enrol in mathematics as resulting from expectancies for

success and the subjective value of the task for the individual. There is evidence that from an early age boys like computers more than girls do (Bernhard, 1990). Lower self-confidence of women and girls is frequently remarked upon (Oakes, 1990; Robertson, 1988). Collis (1987) identified what she called the "We can but I can't" paradox: Girls may strongly defend the abilities of their sex generally, but be hesitant about their own potential and choices.

To the extent that confidence and motivation influence orientations towards science and computing, school-based projects promise to redude female disadvantage. However, there are criticisms that such approaches arise from a "deficit model" which denigrates women's choices, stances and characteristics by regarding them as inferior to men's. The literature on what is involved in becoming expert in any field (Chi et al. 1988) indicates that thousands of hours of specialized attention to a subject are involved. Women may be less likely to specialize in this way (see e.g. Maines, 1985), but having wider interests may then be seen as a deficit.

Many aspects of schooling contribute to gender and other forms of inequity (Acker, 1990); and Oakes (1990) points out that unequal funding of schools can distribute opportunities away from disadvantaged communities. Collis (1987) describes how school policies that require mathematics prerequisites for work with computers, and which locate computer resources in math departments, can reinforce masculine associations. When such new resources come into a school, they are often directed to the location of the old resources. If there is a single computing laboratory it may become seen as a male territory. Other researchers have described a boy-centred "computer culture" growing up in schools or within classrooms. Although some kinds of innovation, e.g. a project in which children write notes for themselves and to one another via a communal computer data base, are successful in involving both girls and boys (Scardamalia et al., 1991), some policies of making computers available in free-time activities contribute to dominance by boys and exclusion of girls (Carmichael et al., 1985; Hawkins, 1985).

Several writers suggest that some classroom practices disadvantage girls. Competitive ways of relating to computers appeal less to girls (Bernhard, 1990; Carmichael et al., 1985). Cooperative groups are sometimes advocated as more

positive ways to involve girls with computers. Mixed sex groups can work to the detriment of girls, as boys may become leaders and girls become helpers or simply give up (Robertson, 1988; Sadker et al., 1991).

Bernhard (1990) notes that the patterns that are disadvantageous to girls are in part a consequence of scarce resources — when there is less provision there is more aggression (p. 69). Carmichael et al. (1985), who observed computer use in 18 Ontario elementary school classrooms report disturbing findings. No difference between girls and boys in computer use occurred during the first year of the study. But during the second year boys had higher average scores than girls on a test of computer knowledge. Classroom interactions at one Grade 7 site, which produced the largest differences, were examined: the greatest problem was the behaviour of the boys. "When it comes to computers, they are sharks," one of the girls said (p. 83). Aggressive strategies, such as starting to print when it was a girl's turn to use the keyboard were reported. Boys discouraged girls by scathing comments, and manipulated them by "trading" computers so that they had no printer or had a machine which they did not know how to use. The teacher seemed helpless.

In this rather gloomy literature there are also descriptions of good practice. Kahle (1985) conducted a study of eight high school biology classes, spread across the USA but all taught by teachers with a record of success in encouraging young women to study science. "Good teachers make a difference," she comments (p. 70). The teachers were skilled, professionally active, confident and knowledgeable. All shared certain practices: use of multiple textbooks, more laboratory and discussion activities, frequent evaluation of work, use of guest, field trips, independent projects, and "attractive, well-equipped and maintained classrooms."

INTERVENTIONS TO INCREASE EQUITY

There is no consensus about the best moment for interventions. Chipman and Thomas (1987, pp. 412-13) point out that the patterns of interest that predict scientific careers emerge early in life. Associations between computers and masculinity are reflected in patterns of computer use in children's homes, by computer magazines directed at males, by computer games which stress aggressive

and competitive themes (Cole & Griffin, 1987; Collis, 1987; Fetler, 1985). Studies in the USA find that boys have more exposure to computers at home as well as at school, and are more likely than girls to be sent to computer camps and summer classes (Fetler, 1985; Hess & Miura, 1985). Thus interventions in the community or in the leisure industry are conceivable. Universities and industry are also singled out by some writers as strong reinforcers of the masculinity of science and technology. However, most interventions are directed at children in elementary and secondary schools. The studies of elementary school children that report boys aggressively dominating computers and excluding girls imply that this is an important time for special efforts, and early adolescence is also frequently singled out as a crucial time (Oakes, 1990; Robertson, 1988).

Accomplishing change in schools needs alterations in materials, teaching approaches and beliefs (Fullan, 1991, p. 37). Beliefs are especially difficult to alter, and teachers' ideologies set limits to what changes they accept (Riddell, 1992). A Canadian survey (Orpwood & Souque, Undated) of nearly 7000 science teachers in the early 1980s found teachers unenthusiastic about giving special attention to girls. Studies in Britain report that teachers are sceptical about initiatives to promote equal opportunities, and negative about feminism (Whyte, 1986).

All interventions must contend with school and classroom realities. This is a basic shortcoming of initiatives imposed from above. Weinshank et al. (1983) argue that the "modal conditions" of teaching are inimical to implementing innovation. Successful innovations require conditions such as support from the principal, time for planning, appropriate resources, teachers willing to work together on a project they believe in. Managing the complexity of the classroom means that any innovations which represent a threat to classroom order may be rejected. Teachers judge an innovation in part by its practicality in their particular situation.

Introducing computers into classrooms is problematic. Several Canadian studies have shown that classroom activity and teacher routine may be disrupted by the arrival of new technology (Carmichael et al., 1985; Fullan, 1992). In a classroom teachers may be torn between attending to the needs of the computer users and the

rest of the class, while a laboratory may present difficulties of scheduling and setting up many machines in a short time.

There is also the problem for teachers of overload. Learning to integrate computer use into teaching can also involve an enormous amount of extra work and in the context of other demands teachers may be reluctant to undertake this. Thus Apple and Jungck (1990) found that, because it helped them cope with a heavy workload, teachers settled for a curriculum unit on computers that required little of them beyond pressing buttons on a tape-recorder.

The message of this literature is that innovations have greater success if they are compatible with teachers' existing beliefs and conditions of work. This may be more likely to occur when teachers themselves are initiators, provided that teacher initiatives are well supported and generalized to have lasting effects (Fullan, 1991).

Initiatives concerned with gender equity, some of which focus on access or outcomes in technology and science, have become fairly common in recent years in many countries. In Canada there have been initiatives at both local and provincial levels (Julien, 1987; Robertson, 1988). In the USA intervention projects have been credited with a rise in high school girls' propensity to follow a full four-year mathematics program (Kahle, 1985), and with strategies that significantly increase girls' use of computers (Sanders & Stone, 1986). From some of these programs have come suggestions of what the key features of successful interventions: highly motivated teachers, strong academic emphasis, and multiple strategies (Cole & Griffin, 1987; Stage et al. 1984). When computers are introduced, they have to be seen as part of a complete system including the social organization of the classroom, the curriculum itself, and the relationships of classroom, school and community, rather than an isolated technical alteration (Cole & Griffin, 1987, p. 56).

CONCLUSIONS

There is widespread agreement that science and technology are essential to the future prosperity and wise use of resources to conserve the environment. This is not to say that science and technology as currently taught and practiced are immune from criticism. Some writers, such as Morrell (1991), believe that the

uncritical equation of scientific and technical advance with economic prosperity also rationalizes neglect of women's traditional occupations such as nursing, which remain underpaid and undervalued. Many feminists resist the encouraging of girls to enter science and technology when it is framed in such a way to suggest that traditional male activities are valued over traditional female ones, or that girls' choices are irrational even if they are responses to a gender differentiated labour market or to wishes to avoid uncomfortable working environments.

Intervention projects are important, but it is not enough to proliferate projects. Many questions arise: Some are straightforward. For example, who should be the target of interventions: girls, parents, teachers, or another group? At what level of the education system will interventions have most impact? Which innovations are most effective? There are also more complex questions. What theories lie behind innovation efforts? Can they move behond a liberal feminist framework? Can they take account of ethnic and cultural differences? We hope to design research to look at a series of projects and consider such issues. The literature we have reviewed suggests these questions do not yet have definitive answers, but there are directions, and there is hope that such answers may be forthcoming.

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ESTABLISHING MENTORING SCHEMES

Judy Emms and Gill Kirkup

Suite à un atelier remettant en question l'acceptation inconditionnelle de l'importance des modèles à imiter et examinant le rôle du mentorat dans l'informatique et la technologie de l'information, on a décidé de tenter la mise en oeuvre d'un projet pilote de mentorat à l'intention des femmes. Les questions fondamentales proviennent de :

- une nouvelle théorie féministe sur l'identité et le sexe qui n'est plus reliée aux modèles à imiter, le concept a été abandonné;

- des initiatives pratiques dans le cadre desquelles les modèles à imiter peuvent conduire des femmes accomplies à se transformer en «*stars*» et d'autres, moins accomplies, en *victimes*. Les modèles à imiter suggèrent également que tout ce qu'une femme accomplie à faire pour aider d'autres femmes, doit être visible. Le projet pilote fait la promotion d'un concept plus actif, dans le cadre duquel les femmes accomplies et les hommes agissent en vue d'aider toutes les femmes à surmonter les barrières structurelles. Les femmes ont besoin d'intervention et d'aide pour passer au travers ou surmonter ces barrières.

ESTABLISHING MENTORING SCHEMES

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ABSTRACT

Following a workshop which questioned the uncritical acceptance of the value of role modelling and investigated the place of mentoring in computing and IT it has been decided to attempt a pilot women's mentoring project. The basic questions arose from:

- new feminist theory on identity and gender which is no longer concerned with role modelling, the concept has been abandoned;
- practical initiatives in which role modelling can lead to creating *stars* out of successful women and *victim blaming* those who are unsuccessful. Role modelling also suggests that all a successful woman has to do, to help other women, is to be visible.

The pilot will promote a more active concept, where successful women **and** men do something to help women overcome structural barriers. Women need active intervention to help them get through, or over these barriers.

INTRODUCTION

Received wisdom amongst most of us working in positive action programmes has been that it is crucial to provide role models of women working in 'masculine' fields such as computing in order to inspire and encourage girls and young women to enter them. There are many references to role models in the literature (see for example previous GASAT proceedings), and great has been the amount of time and energy some of us have spent trying to be a role model or trying to find other women who were willing to do so. But has this time and effort been well spent? Is seeing, hearing or reading about the successes of a relative stranger, even if she is a women, a critical factor in our career choice? Is it not now time to put our energy into a more dynamic model in which a personal relationship between two individuals is used strategically to the benefit of the junior partner in that relationship, that is mentoring?

A CRITIQUE OF ROLE MODELLING

Eileen Byrne (1992) looked for evidence to support role model theory by examining the statistical relationship between the proportions of women students entering particular 'masculine' courses at undergraduate level, and the proportion of

women teaching on those courses. Role model theory would lead us to expect that there should be more women students on courses with more women staff; but this was not the case. Byrne(ibid) argues that the theory should be abandoned because it is not supported by evidence, and also because it has led us to place the responsibility for the under-representation of women and girls with the wrong people. We should be looking for mentoring rather than role modelling.

> [We should be] 'shifting the paradigm from examining the behaviour of girls and women to examining the institutional ecology of disciplines and therefore shifting the responsibility for change from the minority of women in science who are expected to add same-sex role modelling to their existing roles, to the males who control science and technology and who control mentorship, so that mainstream men take direct responsibility for advancing women....
>
> ..... [role modelling] provides an alibi for male inaction. As long as male academics can say 'if we only had more women staff, we would have more women students' they can place the onus for change on women, obviating the need to re-examine prevailing male behaviour as a negative factor.' (ibid, 1992)

WHAT IS MENTORING?

Mentoring is beginning to receive much publicity in feminist writing, this is partly due to the domain in which it has been most developed: management studies, and partly due to the fact that some of its premises about the appropriate ways to achieve personal advancement appear to run counter to feminist ethics of openness and non-competitiveness, which we will discuss later. At its most basic mentoring is

> '... a process in which one person (mentor) is responsible for overseeing the career and development of another person (protege) outside the normal manager/subordinate relationship' (Collins 1988)

It is different from role modelling in that the mentor must DO something for a small number of proteges (or in our case protegees!) with whom they will develop a personal relationship rather than BE somebody for people they may never have much to do with. Unlike role modelling there is now extensive empirical evidence from business and management which suggests that having a mentor can be identified as one of the components of a successful career (McKeen and Burke 1989, Fagenson 1989). It has also

been found that women are less likely than men to have been mentored and to be mentors themselves (Dreher and Ash 1990, Ragins 1989). Although this literature is not based on research in the scientific or technical professions, or academia, what it tells us about career progression applies in these areas too.

There are obvious reasons why men don't choose women as their protegees: they may simply be operating stereotypes in which women and leadership are not compatible; they may not be able to make a personal identification with a woman (or a member of a different class or ethnic group) - an important aspect of any personal relationship; they may never meet women colleagues in their male social surroundings for example, the golf club, or the Masonic Lodge; they may feel that relationships with women are sexual and so either avoid them or turn them into 'affairs'. It is less obvious why women don't seek out mentors, either female or male. Some of this may be to do with the awareness women have about men's sexual fantasies about us that make us wary of initiating relationships with them; or that we don't have access to the social networks that men have (Ragins and Cotton 1991); or that women prefer peer group support and haven't understood the importance of mentoring.

One of the problems with mentoring is that it is rarely systematised or made explicit, so that it is hard for an outsider to get in, or for a company to ensure that its best young entrants were chosen to receive the mentoring they need to get them into the most appropriate high level jobs. The recent concern in industry with 'human resources management' has led to mentoring 'programmes' being established where senior staff are expected to be mentors and their success is incorporated into appraisal systems. (Lorinc 1990, Wunsch 1991). Books such as 'Networking and Mentoring. A Woman's Guide,' (Segerman-Peck 1991), have been written to both convince women of the importance of using a mentor and to give guidance on how to get one, as well as how to be one - probably to another woman. After reviewing this work we were very conscious of the absence of references to mentors in the literature of women in science and technology while at the same time there existed a relatively uncritical acceptance of the value of role modelling.

BEING A MENTOR

The authors explored these issues with colleagues at a feminist computer science workshop in 1992 (Emms 1992). The workshop started by comparing ideal mentoring

behaviour with the characteristics that Segerman-Peck identified as being useful in a mentor:

1. Ability to teach or facilitate learning
2. Wide network of contacts
3. Willingness to share experience
4. Professional/academic qualifications
5. Sharpness of intellect
6. Ability to think on their feet
7. Ability to give advice and then withdraw
8. Organisational skills
9. Wisdom
10. Success
11. Influence
12. Discretion
13. Perception
14. Commitment to the development of young people. (Segerman-Peck 1991, p 65)

We identified in addition, the following mentoring behaviour:

- a positive approach, enabling, instilling confidence
- supportive of risk by providing a safe environment
- flexible, to meet different needs at different stages
- providing a shortcut to increased knowledge of working procedures in reduced time
- sympathetic, non-judgemental
- available
- confidential and trustworthy
- not inclined to favouritism. List 1

When asked to consider their personal needs and skills participants could identify from the lists above both what they needed *from a mentor*, and what they could offer *as a mentor* themselves.

There was general agreement that a systematic mentoring scheme would require:

- co-ordination
- an appeals procedure

- matching mentor with protegee
- training for mentors
- a mentor network
- a mentor contract clearly setting out the nature of the relationship which would avoid difficulties with cross-gender mentoring
- a minimum structure of meetings
- a minimum amount of time in mentoring meetings. List 2

The workshop concluded by producing a list of the questions to be answered before choosing a mentor:

- Where am I now?
- What is my present level of knowledge, skill and competence?
- Who are the people I know?
- What positions do they hold?
- What can they help me with?
- What can they teach me?
- What information do they have that I need?
- Whom do they know who can help me? (Segerman-Peck 1991, p62) List 3

IS MENTORING FEMINIST?

Twenty years of role modelling is not achieving the gains for women that the effort involved - from women - merits. It does seem to be a good time to try something else, and feedback from colleagues suggests that women do see how mentoring could function in their lives. However there are political and ethical problems as well as the practical ones that we have discussed earlier. For example:

> 'if one of its purposes is to teach the protege organisational values and norms to which the protege must adapt for success, then how can the new corporate values and modes of behaviour occur?'
>
> (McKeen and Burke 1989 p41)

The feminist version of this is: if mentoring is about making it easier for women to succeed by learning to act like men, then how do we bring about institutional change so women are valued for what they can bring to a job as women? This is part of the struggle all

feminists take on at any level once they enter a relatively traditional organisation. We, the authors have no answer.

Another problem is that mentoring could perpetuate an 'old *persons'* system that encouraged favouritism, elitism and is anti- equal opportunities. There have always been debates amongst feminists about whether we should be against *all* exclusive networks or whether we should be establishing networks of our own. However we have usually been happier working in peer networks rather than in hierarchical ones. That could be because there were so few of us in powerful situations that all networks tended to be of relatively junior peers. Mentoring asks us to work with senior women and to network with ***men***.

Women are inclined to develop life-long relationships with other women whereas a mentoring relationship will have a limited time span before other needs and therefore other mentors are appropriate. This can engender a sense of individual loss and of leaving something behind when current objectives are met and the *usefulness* of the relationship is at an end. In fact most women are uncomfortable even with the concept of *usefulness* of a relationship. From the other end of the relationship the protegee might be *supporting* the mentor who would also be unwilling to cut the ties developed in the mentoring stage of the relationship. This leads to the question of what happens to the relationship when the protegee moves on?

However similar conflicts have always existed when women committed to change have also wanted to join established organisations. If we think it is worth exploring mentoring as a strategy we will have to continue the debates and develop ad hoc compromises, learning as we go along, in the way we have with all our other positive action initiatives

TRYING IT OUT

Unfortunately mentoring is unlikely to happen by chance, especially between senior men and junior women; it is time to press for some form of formal mentoring scheme. Wunsch (1993) for example reports a pilot formal scheme working very well in an academic environment, and gives us a model that we plan to transfer into computing departments in higher education. Segerman-Peck has provided a detailed set of questions that are useful designing a mentoring scheme.

- Will mentoring be merely tolerated if it occurs informally, or will it be encouraged?
- If it is to be encouraged, will it be formalised?

- Will it fit in with or replace existing development practices?
- Will mentoring support a set development programme, or will it stand alone as a person-to-person development tool?
- What will mentors and mentees expect of each other? Should there be a meeting contract?
- To whom can a mentor, mentee [protegee] or others turn if things go wrong?
- How will problems of resentment and fear of change be handled?
- How long should mentoring from any one mentor last?
- Should there be a recommended pattern of mentoring?
- How will the scheme be monitored and assessed? By whom?
- What administrative support will be needed and provided?
- Who will act as mentors? Will they be volunteers or chosen?
- Who will do the choosing?
- Will mentors be trained?
- Will mentors be assessed on their mentoring? If so, how?
- Should mentoring be part of the job description?
- How should time be allocated to mentoring?
- How should mentoring be rewarded?
- Who will be eligible to be mentored? Everyone by choice, or only those nominated?
- Who will nominate them?
- How will mentors and mentees be matched?
- Who will match them?
- Will mentoring be one-to-one, or one-to-many? (Segerman-Peck 1991 p163/4)

List 4

Our scheme, like that at the University of Hawaii (Wunsch 1992), starts with a needs assessment to help pair senior and junior staff. The questions that were listed, List 3, help determine appropriate pairings. Wunsch's mentoring programme is characterised by an emphasis on three main areas: *Entry level survival needs in the institution, Career development and advancement needs*, and *Socio-psychological needs*. A key component is the production of a mentoring agreement drawn up between the mentor and the protegee. This is supported by training and meetings for the mentors, meetings of the protegees and

a series of seminars on career development. Separate guidelines for mentors and protegees have been produced; these describe the scheme and what to expect from it. The programme also meets the list of needs for such a scheme shown in List 2.

Working with the Equal Opportunities Unit at the Open University, the possibility of a pilot formal mentoring scheme is being pursued with the faculties of Mathematics, Science and Technology. An analysis of the gender profile of staff shows a significant inbalance in women in senior positions within computing, my own discipline. Computing academics are members of departments within Mathematics and Technology and the pilot will concentrate on staff in this area. The current economic recession means that few new academics are being appointed so we have been unable to start a pilot scheme as the number of new women academics is tiny in the relevant areas.

Our first requirement, working to a similar programme as that described by Wunsch(ibid), is to collect statistics and information on current perceptions of the working environment and barriers to women before the mentoring begins so that there is a sound basis for evaluation after participation in the mentoring programme. A yearly assessment of development and changes in perception is appropriate. However career development takes place over a long timescale and significant results can only be assessed in that time frame.

A number of alternative situations for running the pilot have been considered; these include a small project where those of us with more experience mentor those members of staff junior to us and already in post; to extend the pilot to computing departments in other higher education establishments; or to involve women in computing and IT who work in a professional environment. Although the last of these could be carried out locally, in Cardiff, the different organisational cultures and promotion criteria would make comparisons difficult. Such a project would require a different source of funding. Colleagues in other institutions are keen to collaborate but details of the scheme have to be agreed so that the evaluation can be made across the different universities.

LOOKING AHEAD

It is realistic, since women in IT are no different to other groups of women in their need for mentoring and the problems which such a scheme will generate, to explore pilot projects which could form the basis of schemes to be introduced elsewhere subsequently. More details of the scheme we are piloting should be available by the time of the

conference. However the *issues* of whether mentoring is a non-feminist practice, and whether support of selected members of staff is ethical must be debated openly.

Those energies that we have previously put into developing role modelling schemes should now be put into developing mentoring schemes. We are likely to get more benefits from doing so.

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TOWARDS GIRL-FRIENDLY SCIENCE: A SURVEY OF INTERVENTIONS FOR ELEMENTARY TEACHERS IN ONTARIO[1]

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Malgré plus de vingt années d'intervention en vue de promouvoir l'équité dans l'enseignement des sciences, «l'infériorité» des femmes et l'iniquité des résultats ne cessent de se perpétuer. Les barrières systémiques sociales et culturelles auxquelles se heurtent les filles dans le domaine des sciences et de la technologie contribuent à leur sous-représentation dans ces secteurs. La discrimination systémique demande des remèdes systémiques, ainsi qu'une prise de pouvoir renouvelée des membres des groupes désavantagés -- soit, dans notre cas ici, celui des femmes. On reconnaît de plus en plus que la formation d'attitudes et d'aspirations dans les classes primaires est critique. Les étudiantes, ainsi que le personnel enseignant, se doivent d'acquérir un certain degré de pouvoir. Dans ce document, nous abordons tout d'abord la question des domaines qui posent des problèmes au personnel enseignant. Nous documentons et parlons ensuite des interventions spécifiques mises au point pour le personnel enseignant des écoles du palier élémentaire de l'Ontario. Des suggestions pour une intervention ultérieure sont également présentées.

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TOWARD GIRL-FRIENDLY SCIENCE: A SURVEY OF INTERVENTIONS FOR ELEMENTARY TEACHERS IN ONTARIO[1]

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Abstract
In spite of over twenty years of interventions designed to promote equity in science education, girls' underachievement and inequity of outcomes still exists. Systemic social and cultural barriers faced by girls in science and technology help account for their underrepresentation. Systemic discrimination requires systemic remedies and empowerment of those in disadvantaged groups – here, women. The formation of attitudes and aspirations in the primary grades has been increasingly recognized as critical. Female students as well as teachers need to gain a sense of power. In this paper we first discuss problematic areas for teachers. Then we document and discuss specific interventions developed for elementary school teachers in Ontario. Suggestions for future intervention efforts are given.

Introduction to the Systemic Problem

In the Canadian educational system, girls -- like those in certain cultural groups -- constitute a disadvantaged group that may avoid and underachieve in the fields of science and technology (Beauchamp & Feldberg, 1991; Statistics Canada, 1990). We believe that there are no intellectual barriers to girls and women entering mathematical, scientific, or technological careers. Our purpose in this paper is to focus upon the social and cultural barriers, some of which are erected by school teachers and science curricula, that contribute to the inequitable distribution of girls and women in the fields of science and technology. Second, we explore selected interventions in Ontario aimed at improving the situation. Our assumption here is that to succeed, girls must be empowered with a true sense of their capabilities. This cannot be separated from empowerment of females generally, including women teachers, principals and educational personnel, and

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

would necessarily include those of diverse racial and cultural backgrounds. We are not attempting to create a comprehensive review of programs that empower females and challenge sex-role stereotyping. Rather, we focus on exemplary programs in which teachers more effectively and equitably respond to the interests, needs and aspirations of all children. Finally, we will present recommendations for change.

The Teachers

Biased Attitudes. Teachers and guidance counsellors tend to be unaware of the degree to which they have been influenced by preconceived notions of what are considered appropriate behaviours and occupations for women and men (Ditchfield & Scott, 1987). Many teachers of technical subjects believe that qualifications of girls in these subjects will be unimportant and that girls are weak in these areas (Spear, 1985). Forty percent of teachers in an Ontario survey agreed strongly with the statement that it is more important for boys rather than girls, to learn about computers (Moore, 1986). As a result, girls and women are frequently discouraged from pursuing interests in mathematics and science.

Teacher Behaviour. The attitudes, participation and achievement of students are greatly influenced by teacher behaviour in the classroom (Nash et al., 1984). However, teachers of both sexes appear to hold different expectations, behaviour standards, rewards and punishments for female and male students. Boys are often asked higher order questions and receive more praise, direct instruction and listening time from teachers than do girls (Beauchamp & Feldberg, 1991). Girls are frequently "over-helped" in the science and technical classrooms, leading to lack of confidence and reduced competence (Whyte, 1986).

Lack of Teacher Preparation. There are few female science, technology, and mathematics teachers in elementary and secondary schools. Only 25% of elementary teachers have science degrees and more than 25% of elementary

teachers surveyed stated they would rather **not** teach science (Beauchamp & Feldberg, 1991).

Lack of Financial Support for Teachers. One of the major stumbling blocks for teachers is the lack of legislative and administrative support and funding to address gender equity issues[2]. Indeed, a number of exemplary interventions have been de-funded[3].

Interventions Addressing Teacher Related Issues. Clearly, preservice, inservice and graduate education are necessary to alert teachers to the negative repercussions of stereotyping in their classrooms. The stereotyped behaviour of teachers is usually not deliberate. Female teachers in particular, may be eager to promote gender equitable goals. Thus interventions with teachers should not be based on the assumption that teachers are in need of authoritative correction. Various organizations, school boards, and teacher groups in Ontario present materials and workshops for teachers which provide greater mathematics and science content, exposure to recent research on gender issues, and teaching strategies that minimize gender differences[4].

Increasing numbers of graduate level courses dealing with gender issues in mathematics, science and technology education are available. Research is currently underway with a small group of teachers in such a course (Nyhof-Young, in progress) to investigate how the concerns of teachers regarding gender issues in science education can be developed through collaborative inquiry to understand and improve their own practice.

Affirmative Action

For many years, the approach to improve access to science for women and minorities was to provide everyone with the same opportunities in the classroom. This equal opportunity approach did little to reduce between-group differences (Secada, 1989), and most educators now concede that affirmative action is justified

to help a group overcome historical disadvantages, including those in the educational system.

These findings point to the need to measure and overcome hidden variables, such as differential practice and motivation histories. Bernhard (1992) designed and evaluated a girl-friendly preschool program with computers which was designed to counteract gender stereotyping in computer-related skills. Both sexes changed; each found computer-use more appropriate for their own sex. Nonetheless, the boys performed better on the final computer tasks than did the girls, possibly because of an advantage in initial skills, stronger interest, gender difference in play styles, and collaborative work on computers. Strategies that have worked elsewhere to increase girls' performance are as follows: extra time, ensured access, same-sex groupings, and special compensatory instruction.

Curriculum Materials and Issues

Textbooks and instructional materials are treated as authoritative by many teachers and students, and their messages absorbed without question. Sexist bias occurs in at least three forms: a) males are consistently overrepresented in textbooks, when people are mentioned at all; b) examples and references are related to masculine interests; c) males and females are presented in stereotypical roles (Noddings, 1992; Whyte, 1986). Thus texts reinforce the perception of science and technology as masculine. In addition, there is evidence that girls are further disadvantaged by traditional teaching styles (Cole, 1990).

Interventions Addressing Curriculum Issues. The science curriculum has become an important focus for intervention. Whyte (1986) has stressed that the social implications of science should be presented in the first stages of science education. This encourages children to study science for its social relevance. Recently, the emphasis of the science curriculum has become more society-oriented and learning-centred, and deals with issues such as promoting science as a cultural

phenomenon; relating science to wider societal and technological issues; addressing real-life situations based on children's existing knowledge and experience; and enhancing children's self-image and self-worth (Haggerty, 1992; Hodson, 1992). Addressing these issues in the classroom is an important step towards increased participation and achievement of females in science and technology.

The approach of a science course in an all boys' high school in Toronto is particularly noteworthy. A exemplary unit entitled 'Gender and Science' deals with science as an institution, feminist critiques of science, and gender issues in medical research. This unit is currently being evaluated (Nyhof-Young, in progress). There are also several boards and organizations producing curriculum aids for elementary teachers[5].

Parents and Peers

Lack of Collaboration with Parents and Caregivers. Teachers are not the only people who shape young children's attitudes. Preschoolers are especially influenced by stereotypes of parents and other caregivers. The behaviour of students in the classroom is derived from behaviour learned in the home and, in turn, reinforced by school and classroom norms (Noddings, 1992; Whyte, 1986).

A few school boards, and groups such as the Lincoln Women Teachers' Association and Brock University (Ms. Math), and independent consultants (e.g., Moore Learning in Toronto) offer family workshops in mathematics and science designed to help parents become learning partners with children. The programs, which include activities promoting mathematics and science as enjoyable subjects, have generated a variety of promotional handbooks, posters, and presentations. The Toronto Board offers evening Family Math and Family Science workshops to train trainers (teachers and parents within the Board) to implement these programs in community elementary and junior schools.

Detrimental Peer-Group Interactions. By the time children enter

school, many girls and boys are already locked into conventional stereotypes. Unfortunately, schools tend to reinforce these biases. As a consequence, boys commonly express antagonistic attitudes toward girls and femininity (Carmichael et al., 1985; Clark, 1990; Tutchell, 1990).

Gender equity programs focusing only on girls may fall into the trap of assuming that girls, rather than standard educational practices, are the problem. The empowerment of girls requires changes of those power relations in the classroom that cause traditionally "male" activities to be more valued than "female" ones. An intervention that has focused on children's construction of gender is the Toronto Board of Education's 'Boys for Babies' program. Preadolescent boys are taught to feed, bathe and handle babies; they learn that caring for other human beings does not diminish their "Masculinity". The program has generated an enthusiastic response, but hard evidence of success has not yet been presented. 'Boys for Babies' is a small step toward breaking down the traditional "feminine stereotypes". Similar interventions would appear to be desirable in the future.

Lack of Female Role-Models and Positive Media Messages

Empowerment and improved performance of girls generally cannot occur without the presence of female role-models. A variety of programs expose girls to non-traditional role models in order to encourage a broadening of their career aspirations; for example, the Toronto Board's 'Shoulder to Shoulder' and 'Horizons' career programs for girls. Nonetheless, there have been criticisms of these programs in their present form. First, some girls may not be reached by these efforts. Clark (1990) convincingly argues:

> Many girls view their future primarily in terms of marriage and children and, quite reasonably, make the judgment that this conflicts with a full time career. ... the message that 'girls can do anything fall[s] on deaf ears. What is required is a more complex strategy that takes as a starting point girls' aspirations... (p.91).

Secondly, there is a danger that girls exposed to exemplary role-models may come to believe that fair opportunities already exist and to unduly blame themselves for failure (Gaskel et al. 1989; Overall, 1987). Interventions need to be reshaped and systematically implemented at all age levels, particularly at the early ages, when girls are forming expectations about their place in the world. One notable effort to alter children's aspirations at an early age is the 'Primary Career Awareness Program' developed by the Windsor Women's Incentive Program. The aim of the program is to provide children (K-3) with an awareness of potential careers. Using manipulative materials, children construct buildings and services to represent their community. With the introduction of each place of employment, there is discussion on who holds these jobs and who can hold them. By explicitly dealing with life issues at an early age, we can hope to prevent stereotyping and avoidant behaviour patterns, and establish empowering educational environments.

Recommendations and Conclusion

In our view, there are a number of priority issues:

1. Recruit women with egalitarian attitudes and appreciation for other cultures to become math and science teachers.
2. Include gender equity courses in all preservice programs.
3. Provide inservice education to raise teacher and counsellor awareness, knowledge and skills to deal with gender issues.
4. Use conferences and teacher support groups to develop alternative techniques of classroom management. Peer based classroom observations may be valuable.
5. Ensure that teachers promote anti-sexist and anti-racist education to equip all students to be aware of and deal with the effects of gender on their lives.
6. Encourage sex-segregated groupings, where effective.
7. Examine testing and assessment for systemic bias. Tests should relate to real life situations that reflect experiences of both girls and boys.
8. Inform parents of the importance of science and mathematics and, of how their practices may discourage girls in these career choices.
9. Liaise schools with the Ontario Women's Directorate.

Systemic problems in girls' science and technological education are only

beginning to be addressed. Exemplary research has been carried out, but most programs have no well-designed evaluation component. A comprehensive approach is needed to develop programs for all the sources of influence on girls – parents, guidance counsellors, teachers, and peers.

Endnotes

[1] We gratefully acknowledge comments by Nancy Moore, Erminia Pedretti, and Derek Hodson on earlier versions of this paper.

[2] In order to address these issues, the Federation of Women Teachers Association of Ontario (FWTAO) funds teachers' groups interested in developing career awareness activities for female students. Funding for such projects is also provided by the Ontario Women's Directorate.

[3] One notable casualty is the K - 3 program, 'Education for Primary Students on Equal Opportunity,' developed by Jan Coomber of the Peel Board of Education.

[4] For example, the Equity Studies Centre (Toronto Board), the Holy Family Education Centre (Wellington County Separate School Board), Ontario Women's Directorate, the Design and Technology Centre (York Board of Education), Canadian Association of Women and Science, Canadian Congress for Learning Opportunities for Women, the FWTAO, and the Science and Technology in Education Alliance (data base system).

[5] The North York Board (science newsletters and workshops, locally written science units and kits to support the units), the Toronto Board (e.g. 'Horizons', 'Shoulder to Shoulder', 'Snakes and Snails'), the Education and Training Equity Unit of the Ontario Women's Directorate (packages such as a how-to kit for non-traditional career events), FWTAO, Canadian Association of Women and Science. In addition, many excellent videos and pamphlets have been produced for both teachers and students by organizations such as the Association for Professional Engineers, the Ontario Women's Directorate, and TV Ontario. Others have been produced by Ontario Hydro, the Women Inventor's Project, Chromavision, York University and Ryerson Polytechnical Institute.

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THE COU COMMITTEE ON THE STATUS OF WOMEN: A MODEL FOR CHANGE IN POSTSECONDARY SYSTEMS

Laura J. Selleck

Ce document aborde l'organisation, le mandat, les rapports hiérarchiques et les activités du COU Committee on the Status of Women. Le comité, formé en 1985, a entrepris un certain nombre de projets visant à améliorer la condition des femmes dans les universités de l'Ontario. Accès et rétention des femmes dans les programmes de sciences et de technologie sont deux aspects importants des initiatives de ce comité.

Le comité COU a abordé une vaste gamme de questions relatives aux étudiantes, au personnel enseignant et au personnel administratif. On décrit ici certains facteurs qui contribuent à l'efficacité du comité. Les différentes facettes de l'expérience du comité peuvent être transférées dans d'autres juridictions où l'ordre du jour sur la condition féminine touche désormais les établissements postsecondaires. En établissant un dossier d'acheminement dans le développement de ressources utiles, le comité est devenu un organisme reconnu et respecté. Des partenariats efficaces ont été mis sur pied avec le gouvernement et les comités de la condition féminine dans d'autres organismes universitaires. Récemment, le comité s'est adressé à la collectivité universitaire des femmes pour définir les questions et possibilités actuelles de collaboration.

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ABSTRACT

The paper outlines the organization, terms of reference, reporting relationships and activities of the COU Committee on the Status of Women. The Committee, since its establishment in 1985, has undertaken a number of projects aimed at improving the status of women within the Ontario universities. Access and retention for women in science and technology programmes has been a particular interest.

The COU Committee has addressed a wide range of issues affecting women students, faculty and administrative staff. Some factors contributing to the Committee's effectiveness are described. Aspects of the Committee's experience may be transferable to other jurisdictions where the status of women agenda is being advanced within postsecondary institutions. By establishing a track record in the development of useful resources, the Committee has become a recognized and respected body. Working partnerships have been established with government and with status of women committees in other university organizations. Recently, the Committee consulted with the university women's community to identify current issues and opportunities for collaboration.

INTRODUCTION

The Council of Ontario Universities (COU) is a voluntary organization of nineteen universities and associated institutions of higher learning. Its mission includes actively promoting the collective views of its members to government and the public; providing relevant and timely research and recommendations on educational issues; and striving to achieve broad recognition of universities as significant contributors to

the social, economic and cultural well-being of the Province of Ontario.

In Ontario, all of the universities are autonomous institutions with individual boards of governors, although almost 80% of their operating funds comes from the provincial government. COU operates through building consensus among the university administrations, sponsorship of cooperative activities and sharing of expertise, particularly that of administrative staff and faculty who meet regularly as members of affiliated councils and standing committees. The Committee on the Status of Women has been one of the most productive and dynamic of these expert bodies. Aspects of the Committee's experience may be transferable to other jurisdictions where the status of women agenda is being advanced within postsecondary institutions.

THE COMMITTEE'S MANDATE AND COMPOSITION

The COU Committee on the Status of Women was established in 1985, at a time when many Canadian universities were reviewing their progress in improving the representation of women, particularly in the faculty and senior administration ranks. The Committee's terms of reference include data collection and analysis, development of policy advice and sharing of information and ideas relating to the status of women students, administrative staff and faculty. This broad mandate distinguishes the COU Committee from some other very active bodies, such as status of women committees of faculty associations, unions or student organizations, which tend to concentrate on issues specific to their own constituencies. Since its first year, the Committee has enjoyed a successful working relationship with staff at individual institutions and with government. Reports such as *Employment Equity for Women: A University Handbook* (March 1988); *Attracting and Retaining Women Students for Science and Engineering* (June 1988); *Women's Studies Programmes in Ontario*

Universities (October 1989); the *Women's Campus Safety Audit Guide* (July 1991) and an educational video, *Safer for Women. . . Safer for Everyone* (June 1992) have been widely distributed within the Canadian postsecondary community and have been sent to a number of other countries.

When it established the Committee on the Status of Women, COU provided resources that have contributed to a record of productivity, including a separate research budget and allotment of professional and secretarial assistance from the COU secretariat. Individual institutions also contribute the time and expertise of the committee members, who have always been active participants in the writing and research for projects. The relatively informal nomination process for committee membership has fortunately produced a body of dedicated and talented individuals whose joint work is now probably better known than more "main-stream" COU activities.

Since its first year, the Committee has been led by women who have brought political skills, experience in advancing status of women issues in their own institutions, and established reputations for academic achievement. The Committee has been chaired by an academic vice-rector, a dean of graduate studies, a director of continuing studies, and currently, by a professor of biomedical sciences who is also a member of her university's board of governors. Two of the four chairs have gone on to be presidents of Canadian universities.

The diversity of the Committee's membership over the years has been one of its greatest assets. It has always included a balance of faculty and administrators. Some have direct responsibility for status of women issues within in their own institutions or have made these issues the focus of their scholarship and teaching. Having at least one scientist on the Committee has always been a priority. Men with an interest in gender issues have served on the Committee each year. This diversity provides a

variety of perspectives and expertise and will be particularly useful as the Committee enters into more partnerships with other groups. To ensure good linkages with the Council (which is comprised of the executive head and one academic appointee from each member institution) a university president has always served on the Committee. Academic and non-academic administrators are able to provide insights from their particular areas of responsibility as well as links with other professional organizations. The Committee's establishment coincided with some special Ontario government programmes aimed at increasing the representation of women in the university faculty and administration. The Committee received grants from the Ontario Women's Directorate and the Ministry of Colleges and Universities (part of a three-year Employment Equity Incentive programme) for projects to be used by all of the universities in enhancing equity for women. The employment equity handbook, the campus safety audit guide and the educational video mentioned earlier would not have been possible without these grants. The Ministry benefitted from the expertise of the Committee and the project management capacity of COU, and by establishing a track record in the development of useful resources, the Committee enhanced its own credibility with university administrations, government and the wider community.

WOMEN IN SCIENCE AND TECHNOLOGY: A CONTINUING PRIORITY

In its projects on women in science and technology, the Committee has adopted a broad perspective, rather than a narrow focus on engineering and the physical sciences, the areas where women are least represented in Canadian higher education. For practical reasons, it seems advisable to build on disciplinary areas where women already quite well represented. Women students need to be made aware of the opportunities in biomedical and environmental engineering, as well as the more traditional engineering specialties. The concerns of women in all of the science-

based disciplines, including female-dominated areas such as nursing, should also be addressed. Regardless of their professions, women will increasingly encounter new technologies, computerization and the need for life-long skill upgrading.

From the beginning, the Committee was aware that despite impressive gains in university enrolment, women were still significantly underrepresented in disciplines such as the physical sciences and engineering. In its first year, the Committee began a cooperative project with another COU committee that dealt with student statistics and enrolment issues. Using data from the Ontario universities' centralized application service, the high school credits and grades of female and male applicants were examined. The analysis showed, as expected, that a smaller proportion of women students had the science and mathematics credits required for entrance to science and engineering programmes. But even those women who had all the required credits were less likely than their male counterparts to choose math, science and engineering at university level.

In 1987, the Committee issued a short report, "Women in the Universities of Ontario," which targeted as a major concern the under-representation of women in engineering and applied science and in mathematics and physical sciences at all levels. A graduate student was hired in summer 1987 to review the literature on women's low participation in the sciences. This background research was used in preparing *Attracting and Retaining Women Students for Science and Engineering* (June 1988), a menu of suggested initiatives for improving the recruitment, access, and retention of women students.

While this report was being prepared, the Chair of the Committee wrote to the Canadian Minister of State for Science and Technology and urged that new federal science scholarships be particularly aimed at groups (such as women) who were under-represented in university science programmes. We were pleased to see that

the guidelines for the scholarships issued later in 1988 specified that each institution's candidates for the scholarships must be at least 50% female. By the fall of 1988, over 1,000 copies of *Attracting and Retaining Women Students for Science and Engineering* had been printed and distributed. One result of this wide distribution was a meeting with representatives of the Canadian Association for the Advancement of Women in Science and Women in Science and Engineering. COU was able to assist these groups by mailing their newsletters to deans and department heads through the Inter-University Transit System, which serves all of the Ontario universities.

The Council of Ontario Universities was impressed with the Committee's *Attracting and Retaining...* report and asked the Committee to seek ways to operationalize its recommendations. Since the issue was clearly timely and important to all educational sectors, as well as to employers and government, the best strategy seemed to be to engage the interest of a high-level advisory group on economic renewal, the Ontario Premier's Council. A proposal for a Centre for the Advancement of Women in Science and Technology was developed, modelled on some very successful university-industry research centres. The proposal was sent to the Premier's Council in 1989, and was followed by personal contacts with individual members of the Council. The concept of a Centre for the Advancement of Women in Science was not taken up, but we continue to believe it would be extremely effective and intend to propose it again when a new opportunity arises.

A short brief was presented at the 6 March 1991 public forum sponsored by the Canadian Committee on Women in Engineering. Major points in the brief were the need to encourage women's participation in science and technology generally (rather than focusing too narrowly on engineering), the importance of continuing support and coordination (rather than one-time initiatives), and educating students about the multiplicity of engineering career opportunities.

In September 1991, advice was provided to the Ministry of Colleges and Universities about proposals for improving the climate for women in faculties of engineering. The Committee has also attempted to monitor the workshops for engineering faculty and staff that were the eventual outcome of the Ministry strategy.

CONSULTATION AND FUTURE PLANNING

At each of its regular meetings during 1991-92, the Committee consulted with representatives of the university women's community. The consultations were used to identify issues of immediate concern to women students, faculty and administrative staff, and plan new projects which would be most beneficial to both the senior administrators and the community of women in the universities.

The consultations and the earlier work of the Committee on campus safety made us aware of the complexities of safety and harassment issues in universities, ranging from a growing problem of harassment of women faculty by students to the need to provide security for women working alone at night in laboratories or offices.

University status of women officers and student representatives said that despite efforts made to attract more women into graduate programmes in the sciences, universities are losing their best women students because of the chilly climate in the labs, harassment, and the double disadvantage faced by visible minority women. These climate issues are especially significant as universities move beyond attracting women students and faculty to engineering and science towards ensuring their retention and educational and career progress. There was also concern that women now embarking on academic careers may face additional deterrents, such as granting agency cutbacks and criteria and mechanisms for grant competitions or promotions that are not sensitive to the career patterns of women.

One result of the consultations was a decision by the Committee to take a more

active role in creating a network of university women. This year, plans are underway for a networking newsletter and perhaps an annual meeting of representatives from the faculty, staff and student associations. This movement toward partnerships with other groups mirrors other emergent developments in Ontario postsecondary education, such as a closer working relationship between the universities and the Colleges of Applied Arts and Technology. The Committee's 1992 report on the consultations and strategic planning process included a diagram representing the networks which now exist and which should be strengthened.

The report also presented a three-year work plan, including two projects on women in science. In the first year, a meeting has been requested with the two Premier's Councils (one on Economic Renewal and one on Health, Well Being and Social Justice) to bring postsecondary women's issues to their attention. In the second year, we will begin a study to determine an appropriate methodology for identifying characteristics of science faculties or departments that are hospitable to women. We also have plans for other projects that are relevant to women and science, such as discussions with faculty of education representatives about the importance of gender issues in teacher education. Despite changes in attitudes in recent years, our Committee members still hear about cases where teachers' attitudes or inappropriate counselling are discouraging girls from further study and careers in the sciences.

Later, the Committee hopes to meet with educational television representatives about using television and distance education to educate about both the importance of increasing women's participation in the science and providing broader exposure for women science faculty and for those who teach from a feminist perspective. New provincial initiatives on use of advanced telecommunications in an "Open Learning" system may also provide opportunities, as do some projects on the agenda of a provincial Committee on University Restructuring.

The Committee is also concerned about security for women (and for men) who work alone or late at night in university laboratories. Other COU groups, such as the association of university security officers and the deans of graduate studies may be approached about the possibility of a joint project.

A STRATEGY FOR THE FUTURE

It seems an opportune time to build on the current interest of government and the presidents of universities in science and technology as contributors to economic renewal. In Canada, as in many other countries, we hear constantly about the need to educate more people in mathematics, science and technology, in order to improve the country's competitive position. Although we might prefer that government, business and educational leaders encourage higher participation of women in science and technology because of commitment to social justice and the maximization of individual potential, there may still be opportunities we should not miss in the economic renewal agenda. For example, universities are already realizing that they have to take seriously long-expressed concerns about chilly climate and gender-harassment in faculties of engineering if they want more women to enrol and graduate. Similarly, if universities want to retain more women scientists in their laboratories and classrooms, they will have to ensure a safe and secure work environment, and adopt employment and tenure policies that accommodate family responsibilities.

Women's science and education organizations and committees should work for campus-wide improvements that will benefit women in science and technology. At the same time, we should use well-publicized expressions of concern about the shortage of women into science and technology as a lever to help transform our universities into truly people-friendly institutions.

YOU HAVE TO DO MORE THAN JUST TELL THEM!

Helene Sorensen

On s'aperçoit, lorsqu'on oeuvre dans le domaine de la formation interne des professeurs de sciences, que ces derniers hésitent encore beaucoup à modifier leur attitudes en vue d'atteindre l'objectif clé d'un enseignement des sciences sans discrimination des sexes.

Tout d'abord, nous avons les professeurs de sciences qui estiment que la question des sexes n'a pas d'importance - certains d'entre eux trouvent même «dégoûtants» d'entendre parler du «problème des femmes et des sciences».

Ensuite, nous avons les professeurs de sciences qui pensent que l'enseignement des sciences sans discrimination des sexes n'est qu'un outil visant à motiver les filles.

Le troisième obstacle que nous devons surmonter est celui du comportement stéréotype des élèves, qui rend notre tâche pénible pour l'inclusion des filles dans les sciences. Il faut un temps considérable pour parvenir à modifier des attitudes et des attentes ancrées chez les élèves et dans les antécédents familiaux depuis si longtemps.

Enfin, j'ai relevé, dans mes travaux de recherche des trois dernières années, quelques difficultés provenant du fait que le personnel enseignant hésite encore beaucoup à modifier son rôle.

Ce document traite de la question de la formation interne des enseignants qui tentent d'élaborer de nouvelles méthodes.

Les travaux de recherche reflètent une amélioration de la qualité de l'apprentissage, à savoir que les élèves sont désormais en mesure de choisir leur propre situation d'apprentissage et qu'elles et ils en sont responsables. Ceci est valable tant pour l'éducation du personnel enseignant que pour les sciences à l'école. La méta-cognition est considérée comme un important outil visant à développer la confiance en soi chez les enseignantes et enseignants.

YOU HAVE TO DO MORE THAN JUST TELL THEM!

Reflections on Gender and Teacher Education in Science.

Helene Sørensen

The Royal Danish School of Educational Studies

ABSTRACT

Working with in-service training of science teachers you recognize several barriers among the teachers against changing their role as teachers trying to create a gender-inclusive science teaching.

First of all, you have science teachers assuming the gender question to be without importance - and some teachers even find it disgusting hearing about the ´girls and science´ problem.

Secondly, you find among science teachers several who regard gender-fair science teaching only as a question of the girls´ motivation.

The third difficulty trying to include girls in science lessons rises because of the pupils´ gender stereotype behaviour. It takes a long time changing attitudes and expectations among the pupils and in their home background.

Finally, I have in my research work during the last three years recognized difficulties in the teachers themselves against changing their role as teachers.

The paper will report about in-service training of teachers trying to find new ways.

Research work shows improvement of the quality of learning when the pupils are allowed ownership of their own learning situation and when they are responsible for their own learning. This is valid for teacher education as well as for school science. Metacognition is seen as an important tool to develop self-confidence as a teacher.

The Danish Primary School System

Before discussing the role of the physics/chemistry teachers to create gender-inclusive science classrooms I find it necessary to introduce the Danish Primary School system (the 'Folkeskole').

In Denmark nine years of education is compulsory, from the age of seven to the age of sixteen. In the Danish primary schools the children may start at the age of six in a "kindergarten" class and they stay in the same school until the age of sixteen at the ninth grade. Some of the children choose to study one year more at the same school, but the

tenth grade is voluntary. Others leave school and about one third continue their education in the "Gymnasium".

From the first grade a group of children (around 22) stay together in one "class" until the ninth (or tenth) grade. Often the teacher in Danish language will follow the group of children from the first to the ninth grade (or tenth) with a special responsibility for the group.

It is common that a group of children (a class) at the first grade has two or three different teachers. It is also common that the teacher of Danish language, as mentioned above, as well as the teacher of mathematics teach the group of children for nine or ten years.

From the third grade the class may have other teachers in other subjects such as science or foreign languages, but even then those teachers follow the class during the years in which the subject is taught. In the grades eight to ten the children may follow courses at two different levels in mathematics, foreign languages, and physics/chemistry.

The childrens' education in science begins with integrated science (without physics and chemistry) in the third grade. From the fifth grade to the seventh the children follow courses in biology and geography. At the seventh grade the education in physics and chemistry starts with integrated courses in physics/chemistry, two lessons a week during three years.

In Denmark natural science takes up an astonishingly small part of the curriculum. It now looks as if the pattern will change and education in physics and chemistry will be introduced earlier than the seventh grade. We hope our new Government (January 1993) will confirm a new law for the school system introducing science from the first grade.

In Denmark education of teachers for the 'Folkeskole' takes place in teacher training colleges. It is a four year education in general teaching with a certain degree of specialization in 2 subjects, (for example physics/chemistry and geography). The in-service teacher training either takes place at the teacher training colleges or at the Royal

Danish School of Educational Studies. The last mentioned also provides further education for teachers studying to have their master degree in education.

Science Teachers' view on Gender and Physics

During the last 5 years I have worked with teachers doing in-service training. Discussing girls' and boys' participating in science lessons, some teachers deny any differences between girls' and boys' perception of and learning in science even if they are confronted with statistical material about the participation of women in science careers. Those (often male teachers) get aggressive discussing the topic. In order to get those teachers to reflect on their own way of acting, I have tried to set up situations where teachers' sex-stereotyped interacting in working with some elected topics in science became evident. In-service training courses I often use work about electricity to make them show sex-stereotyped behaviour patterns. In reporting back later on in the course about their own teaching in science some of those teachers told about strategies they had used to overcome for instance boys' dominance in science lessons.

Some teachers stress that the problem concerning girls and physics has been solved. Why still discuss those questions? they say, we have heard enough about girl-friendly science. Those teachers may change their attitude after discussions with other teachers. However a way to influence those teachers has proved to be to organise teacher supervision i.e. teachers visiting each others classrooms and discussing interaction patters on equal terms.

In 1989 we got a curriculum for physics/chemistry in Denmark with the possibility for teachers to create a gender-inclusive teaching. It is possible to relate the matters in physics and chemistry to phenomena in the nature and/or to put them into a personal or social relation. Some teachers use girl-friendly contents as a motivation trick. But if the learning climate in the classroom is based on competition and allows the boys to dominate, even the most 'girl-friendly' content will not lead to the girls' active participation in the learning of science. A 'girl-friendly' content used only as motivation

may even create difficulties later in assessments and examinations if the girls stick to the wide perspective and thus choose not to work with the concepts that the teacher really wants.

Why do I wish to work with Changing the Roles of the Teachers?

In my Ph.D.-project, however, I found the teachers as key-persons in making gender fair science education. The teachers' attitudes, expectations and way of interacting with the students, their preferences for teacher centred or pupil oriented teaching style have a greater influence on girls' participation in science lessons than the choice of subjects in science.

It is obvious from reading the different contributions to the GASAT-meetings over the years that a lot of factors are influencing girls' participation in doing science. It is also clear that many of those factors are cross-cultural. Those factors influencing girls' taking active part in science lessons are not independent and are at play at the same time.

As we have seen from reports, however, cultural differences may give a shift in the usual patterns about girls' participating in science education (Fensham, Klainin and West, 1987). Some of the factors may be changed through actions from the government and school authorities such as changing in the national curriculum. Others are changed through the slow transformations in society over the years. Several of the factors define the classroom situation and the frame around the teaching for the single science teacher, and those factors cannot easily be changed by the teacher. The teacher may create changes around her/his class, but family-expectations, peer group influence, the socio-economical situation in society and other factors out of range of the teacher's influence may lessen the outcome of changing strategies in science education.

Nevertheless, the teacher is able to influence a lot of the settings around the class and has got several possibilities to create learning surroundings able to give girls optimum possibilities for learning science in a given situation. The teacher has thus a great responsibility for creating a gender-including science education.

My Ph.D.-project 1987-90 indicated that in classes where the girls took active part in the science lessons the pupils had influence on their own working situation and were allowed a certain degree of self determination.

To try to investigate the role of the teachers more closely I planned an action-project involving teachers from a school south of Copenhagen. The project received two years funding from the Danish Research Council for Humanities. From 1990 to 1992 I worked with a qualitative research project dealing with changing the role of science teachers in primary schools. The aim of the project was to observe if the pupils were allowed to get the ownership of their own learning process in science lessons with a great amount of practical work.

My findings seem to indicate that it is not at all simple for a teacher to generate new interaction-patterns in the classroom.

My Project on Changing the Roles of the Teachers

My project consisted of two parts. One part was a follow up on two of the classes from the Ph.D.-project, and they make together a longitudinal study (Sørensen, 1991). I followed one of the classes from the sixth grade to the final examination at the end of the ninth grade. The other one I have worked with since the third grade, and I shall follow the class until the final examination in June, 1993. Both classes have had physics and chemistry before the seventh grade, being in Denmark the normal grade to start. I shall not go into further details with the results from this part of the research, it has been presented in earlier GASAT - contributions (Sørensen, 1990 and 1991).

In the other part of the project I worked with a group of teachers in science and Danish language about teaching science to pupils, grades three to six. I wanted to investigate whether working with pupils' activities in science could persuade the teachers to let the pupils get ownership of their own learning process. I started the project with a short introductory course for the teachers involved. I also interviewed the teachers involved about their role as teachers, about their opinion of their pupils and their

expectations of the girls and the boys in the class.

Later on I worked as a consultant for the teachers who took up science activities with the pupils. I observed in different classes for a shorter or longer period of time. I worked especially with three of the classes several times during the two years (grade five the first year and grade during six the second one). Their teachers of Danish language used to working together. They often planned some weeks' work together - I was participant observer in small units like 'Chemistry in the Kitchen', 'Sound', etc.. Sometimes they taught their own pupils for the whole period, on other occasions they split the three classes in groups and taught a special subject to each different group.

After each period I took part in evaluations and discussions with teachers and pupils. I also interviewed the teachers after each period.

I wanted the group of teachers I worked with in this project to set up learning situations allowing the pupils influence on their own learning situation.

It appeared however that in planning and structuring the different work units the teachers tended to choose very structured materials. Often teachers tend to feel the need of being in control of the classroom. For me it looked as if they tried to obtain that no one among the pupils at any moment should be without information about what to do.

When do Pupils experience themselves as Learners.

When one of the the teachers was asked why she used teachers' explanations and teachers' talk to that extent in the physics/chemistry lessons she claimed to do so because of the pupils' request. They wanted to be assured of learning what was in the textbook. They normally to a high extent worked with experiments on their own. One of the conclusions in improving the quality of teaching and learning (Baird and Mitchell, 1986, p. 286) was: 'Students have definite, conservative and restricted views about what constitutes learning and what are appropriate teacher and student classroom behaviours. According to the students, teachers give notes which contain right answers. Real work involves copying and memorizing these notes for tests which measures the ability to state

the right answers'. In my work I have met similar statements from pupils.
Both teachers and researchers have to be aware of those feelings among the pupils. The conception about learning among pupils have to be made explicit and discussed before any changes in learning habits would be able to occur.

Changing the Roles?

The teachers who was involved in the project did not behave differently from their normal attitude when the pupils were to work independently with investigations.

The teacher normally very controlling reacted in the same way in this situation. The pupils felt that he controlled them and their results while walking around the classroom in order to assist them.

The teacher who normally planned everything to the smallest detail and gave the pupils no freedom to express their own opinion was also very restrictive in her planning of the education and in the discussion of the results. However, the pupils were able to sense that they were within an area with which the teacher was unfamiliar, and they were happy that the teacher had to listen to them and ask them about their results.

The teacher normally allowing the pupils freedom and possibility of expressing themselves acted in the same way when the pupils made experiments.

Both pupils as well as teachers expressed these evaluations in interviews.

The teachers are aware of their own roles as teachers. To a certain extent they express that they wish to make changes in their interactions with the pupils.

My evaluation of the project is, that I have recognized the difficulty for a teacher in changing her/his role of a teacher, even if she/he does have a positive wish to do so. The preconscious expectations and views of yourself as a person and as a teacher (your habitus) become a guideline for the deliberate choices one as a teacher tries to make while teaching (Bordieu 1977).

Reflections

Setting up my last project I was inspired from the work done with meta-cognition as a help to the learner to understand and develop learning process and learning practice (Baird and West 1986, Fensham 1989). I wanted to work together with teachers trying to let them develop their meta-cognition about their way of teaching. I wanted the teachers to let the pupils have influence on their own learning situation.

Asking the pupils' and the teachers' opinion of the outcome of the different teaching work units you will get the answer that they have been successful. Judging by the girls' participation in the lessons you do not doubt the positive outcome of the research and development work.

Looking at the changes in the teachers' way of teaching I find too little development towards those changes I should have liked to occur.

I have mentioned the difficulties for people to change their habitus as an explanation of the small changes in the teachers' role as teachers.

Another reason may be the limited time the teachers and I had to work together during the periods of science projects in those classes. Another explanation of my feeling of too little development may be due to the fact that it was my goal more than the teachers' to let the pupils get more influence in the classroom. Furthermore it may be too difficult in the Danish culture pattern to discuss problems too close to the individual teacher's personality. It is a very sensitive subject to discuss matters so closely related to another individual´s personal appearance.

Nevertheless, I want to continue the work with groups of teachers doing research on how to develop meta-cognition about teaching and work with meta-cognition as a method to make the pupils better learners in physics/chemistry. Together with another researcher I have planned a project for the next academical year. We will work with a group of teachers with a personal wish for developing new ways of teaching and a commitment for changes. The developing project will be a part of their job and they will have time for supervision each others lessons and for discussions.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Conclusions

To create a positive learning environment for the girls in science lessons it is important to let the pupils have influence on their own learning situation. The girls want to feel involved on the personal level in the science lessons to maintain their interest in doing science. Many teachers feel a necessity to be in control of the classroom and to teach more than giving the pupils a possibility to learn. More work need to be done developing changes towards new roles allowing the teachers to present to the pupils possibilities of improving their role as learners.

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Collaborative Research and Teacher Development: Issues For Feminists Working in Science Education

Jane Gilbert, Elizabeth McKinley and Beverly Bell

Un grand nombre d'études ont démontré le faible taux de participation active des filles et des femmes dans le secteur des sciences. Bien que ces études ne datent pas d'hier, aucune stratégie de travail efficace avec le personnel enseignant et les étudiantes et étudiants n'a été mise en oeuvre à ce jour dans les salles de classe.

Des chercheuses féministes font actuellement la promotion de méthodologies de recherche concertées qui permettront d'examiner le processus de perfectionnement personnel enseignant.

Toutefois, certaines questions relatives aux méthodologies concertées demeurent en suspens et d'autres, qui adressent la question du perfectionnement des enseignantes et enseignants en ce qui concerne les sciences et les femmes, semblent difficiles à mettre en pratique. Le document suivant aborde certaines de ces questions sur la base de nos expériences en matière de recherche et de promotion du perfectionnement du personnel enseignant.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Collaborative Research and Teacher Development: Issues For Feminists Working in Science Education

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Abstract

There is a large body of research which has documented the lack of active participation of girls and women in science. Although this body of research has existed for a considerable period of time, strategies for working with teachers and students which are effective in implementing change in the classroom have not yet been developed.

Collaborative research methodologies are currently promoted by feminist researchers as a way of investigating the teacher development process and as a means of teacher development.

However, there are some issues related to collaborative methodologies that have yet to be addressed and others that have proved to be problematic in practice when considering research on teacher development in the area of girls and science. The following paper articulates some of these issues based on our experiences of researching and facilitating teacher development.

Introduction

In this paper we review an aspect of the research on the professional development of science teachers, that of collaboration. Our aim is to clarify some of the issues involved in facilitating the process of changing the assumptions and implicit theories that individual science teachers have about girls and about science, and about the relationship between them, and their classroom actions. In doing so, we present different perspectives, as each of us has been involved in teacher development in different areas and has had different experiences.

Research on teacher development falls into the fourth strand of research suggested by Dunne and Johnston (1992) — that of practical intervention strategies which aim to produce a learning environment more favourable to girls by changing science teachers' conceptions of the categories of *girls* and of *science*.

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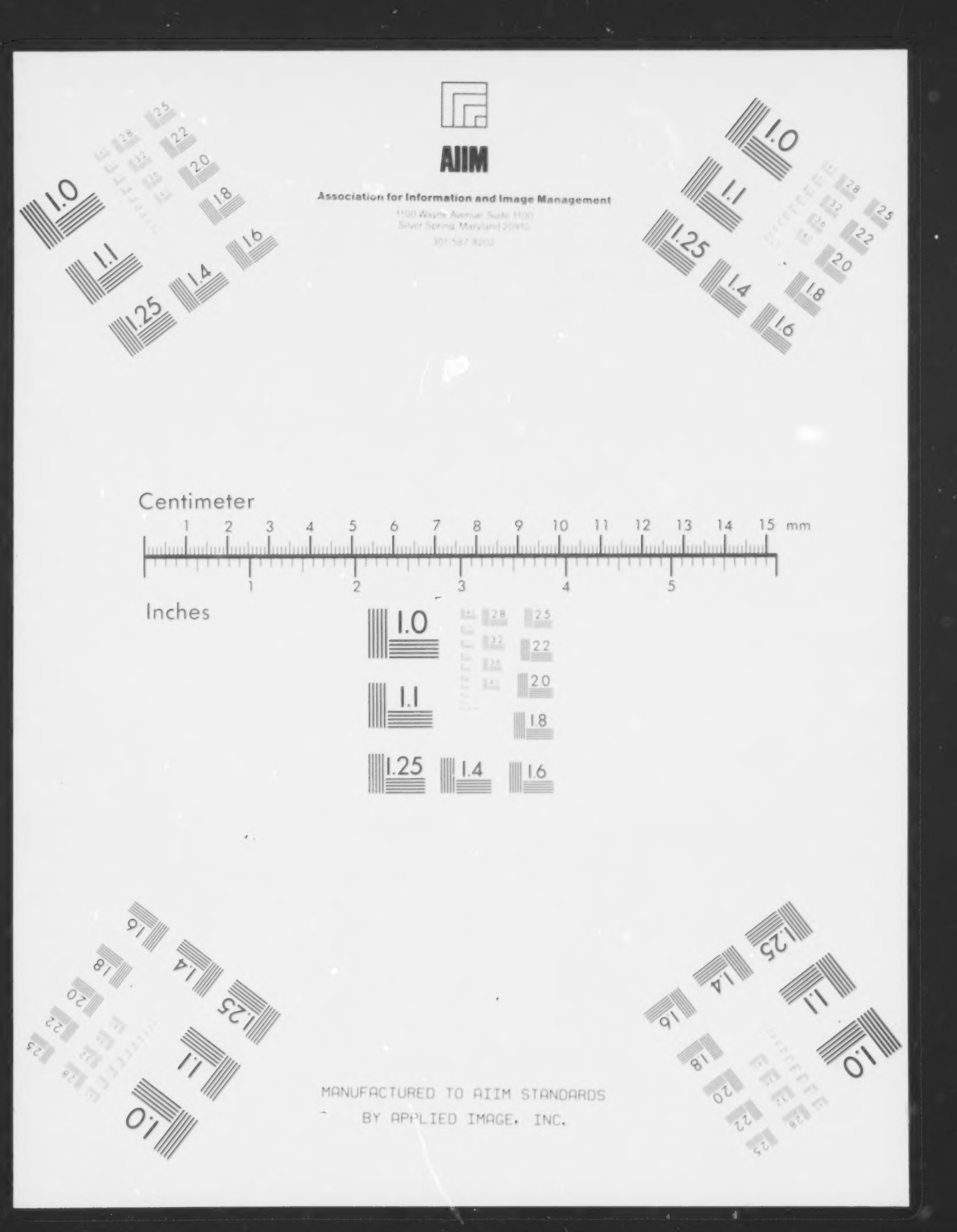
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We are focusing on teacher development research which is based on collaboration between teachers and researchers because it seems to us that collaborative research methods have the potential, firstly for making it possible for teachers' implicit theories to be articulated, and secondly for creating the conditions necessary for teachers to critically examine, and modify if necessary, their theories about girls and science and their classroom actions. The research methods themselves may be used to investigate the process of teacher development and they are themselves an effective method of teacher development.

We review the origins and development of collaborative research methods as they have been used in education, and then look briefly at two research projects with which we have been involved, in which collaborative techniques were used. We then look at some of the issues involved in using these methods in practice, and suggest some implications for the use of collaborative research as a method of teacher development.

Critical theory

Educational research based on collaborations between teachers and researchers has its origins in what has been called critical theory. Critical theorists in education focus on the location of schools within the wider power relations of society. They are interested in the idea of "teachers as intellectuals" (Giroux, 1988), arguing that teachers can and do reflect on their own practices and make changes on the basis of this reflection, and in the notion of teacher empowerment. They argue that basic changes in the way teachers think about and carry out their work can only be achieved by working together in small collaborative groups.

Collaborative research methods

The term collaboration is used widely in educational literature, in a wide variety of contexts — from student-student collaboration in classroom learning situations, to teacher-teacher collaboration in the planning and teaching of school programmes and teacher-researcher collaboration in the design and implementation of educational research programmes.

It is now commonplace for it to be argued that *student* learning is enhanced in collaborative environments. It has also become common to argue that improved *teaching* programmes are produced when teachers plan collaboratively, and more recently, to argue that educational research programmes benefit from the active collaboration of researchers and teachers in the design and implementation of the programme.

Collaborative approaches began to be used in educational research because of the failure of traditional research programmes devised and carried out by university-based researchers to produce changes in classroom practice. In much of the current educational research literature, it is argued that while many of the programmes designed within this framework have been useful for the collection of data on student and teacher behaviour, this kind of research cannot serve as an appropriate framework for the initiation of changes in teacher behaviour. It is also argued that an essential component in any teacher development programme is the active involvement of teachers in their own professional renewal — examining, reflecting on and possibly modifying their practice.

In earlier examples of this type of research, it was common for collaborative models of educational research to be supported on purely pragmatic grounds — that teachers must be actively involved in such research because they had direct access to the classrooms in which the suggested teaching strategies were to be tested, and thus were in a better position than the researchers to judge the efficacy of the strategies, and that their involvement gave the research a credibility with other teachers that it might not otherwise have had (Erickson, 1992). It is, however, now more common to argue for the use of collaborative research designs on more theoretical grounds — to argue, on the basis of Schön's work on reflection (Schön, 1987) that the development of pedagogically functional knowledge must be constructed in the practice setting (Erickson, 1992).

This shift in the reasons used to justify the use of collaboration necessarily involves an alteration in the power relationships within a collaborative relationship. It involves a shift in focus for the university-based researcher — from the role of expert to a role of

co-learner and joint creator of an evolving expertise in a context in which the contribution of all participants is actively sought and valued (Hollingsworth, 1992). If the research is to result in some form of educational change, the teacher-researcher relationship must be characterised by symbiosis, interdependence and mutual benefit (Cole,1989).

This ideal has proved to be rather difficult to achieve in practice. The following sections describe our involvement in research into the professional development of teachers in the areas of developing constructivist views of learning (Bell, 1993) and teaching science in an indigenous language (McKinley, 1991). These projects used collaborative research methods. We look at some of the implications of the use of collaborative research methods, based on our experience with these projects.

The Learning in Science Project (Teacher Development)

An example of collaborative research with teachers is the Learning in Science Project (Teacher Development) (Bell, 1993). This research was undertaken to investigate the teacher development process for teachers of science who wanted to implement the research findings of the previous Learning in Science Projects (Osborne and Freyberg, 1985) on constructivist views of learning in science, and teaching that takes into account students' thinking. This previous research challenges teachers to not only change their classroom practice but to develop their conceptions about learning, learners, teaching, the roles of the teacher, the nature of science, and the curriculum. In the teacher development research, the main focus was the factors that help or hinder the professional and personal development of the teachers - both personal and professional. Twenty-one teachers were involved in 1990, twelve in 1991, and eleven in 1992. The data collected was mainly qualitative self-report data from the teachers in on-going interviews, pre and post-surveys, the audio-taped programme sessions, and journals. The purpose of the research is not unlike that proposed for that investigating how to help teachers implement or take into account the research on girls and science education.

The teacher development research was intended to be collaborative so that the teachers were not just the subjects of the research but also participants in the research process. This reflected a view of the university researchers that the teachers had valuable skills and ideas to contribute to the task of developing the teacher development programmes to be researched and to the task of interpreting the data and constructing understandings of the change process.

We endeavoured to make the research collaborative in several ways. Firstly, the data consisted mainly of teachers' self-reports, and the analysis included the teachers' constructs about their own professional development, as well as the developing constructs of the researchers, two of whom also facilitated the programmes. Secondly, the teachers had a copy of the data they had generated. They were given the opportunity to alter the transcripts before the analysis began and they had the opportunity to read each draft analysis and request changes before it was made public. Thirdly, the research could be described as action-research in two ways. The data collected and analysed in one year by the university researchers influenced the teacher development programme the following year. For example, the sharing sessions began in a modest way and became more and more important in the programme as the teachers feedback to the researchers made their value in promoting support, feedback and reflection for the change process clear. The teachers were also encouraged to be researchers, collecting data from their own classrooms, as part of action-research to help them develop their own teaching.

At the end of the project, the question can be asked "to what extent was the research collaborative?" Over the three years of the project, only half of the teachers have remained involved to the extent of attending feedback sessions on the draft analyses, mainly because of time constraints and school responsibilities. The draft analyses were never substantially challenged or discussed by the teachers and the only changes requested were small editorial changes to the transcript quotes to re-word colloquial speech or to tone down a strong statement. Did this mean the researchers had told the teachers' story? (Bell, 1992). Or did it reflect the unequal power relationships and

the differences in research experience between the university researchers and the teachers as researchers? (Riddell, 1989).

The desire of many of the teachers to continue to be involved in the research was strong. But was it more to be involved in the teacher development as part of the research or to be a part of the research process? It has challenged us to consider why teachers become involved in research and to address the question of what teachers are gaining by being involved in research. The reciprocal relationship, with respect to benefits (Bell, 1992) was probably not symmetrical. While the university researchers wanted to create new knowledge about the teacher development process, the teachers wanted to become "better teachers" and to get "better learning" in their classrooms (Bell, 1993). The process of being interviewed and of considering the draft analyses was helpful to the teachers in promoting reflection and the reconceptualisation of their teaching.

During the research, the notion of teachers as researchers was discussed with the teachers and they were encouraged to collect classroom data to help them develop their teaching. However, the teachers tended not to collect systematic data but rather information to support their sharing of anecdotes — for example, their students' responses to an interview-about-instances on floating and sinking (Bell, 1993). In what sense, were we co-labouring if we had a different view of research and data collection?

The teachers felt as though they were a part of the research — for example, they would contribute orally to sessions at national science teachers' conferences and staff development days. But the ownership of the research is very definitely with the university researchers. They initiated the research, set the problem to be researched, and invited the teachers to be involved. The expectations on university staff to do research and the funding agency's request for research findings on which to make policy, meant that the teachers' involvement in and ownership of the research was inherently lower.

Teaching Science in Maori

From the time of European contact my people have provided fertile ground for research by others. Early ethnographers, educational researchers and occasional travellers described, explained and recorded their accounts of various aspects of Maori society. We have lived a history of "others" putting us under the microscope and giving themselves the power to define and describe (Smith, 1991). Research has done little to extend the knowledge of Maori and has left a legacy of ideologically laden data about Maori society. It is from the position of being the *researched* that Maori have resisted and challenged social science research. The challenge confronts research methodologies as well as the presuppositions about knowledge that underlie research.Parallels can be drawn between feminist literature on research methodologies and the conclusions we, as Maori, have come to through our experiences of *being* researched. In a bid to have more control of our lives, we have set up an alternative education system where the Maori language is used as the medium of instruction and the schools are based on Maori philosophy, values, practices and beliefs.

My research project was carried out with teachers in these schools and focussed mainly on examining teachers' practice. As this was the first research project of this kind in Aotearoa/New Zealand, I had no pre-existing framework on which to base the research. I had to deal with the high degree of scepticism about research that exists among Maori — as a result of the many years of being the researched, with concerns about the extent to which the school and local community would benefit from the research, and with concerns about the extent to which the research was based in *kaupapa* Maori. Although my aim had been to collaborate with these teachers in their professsional development, on looking back I can see ways in which the extent of the collaboration could have been increased.

The notion of collaboration.is embodied in Maori conceptions of the process of knowledge development. It is important to Maori that research teams are built on the concept of *whanau*, in which the contribution of all the members is essential and equally valued.

Maori ways of evaluating knowledge are strongly influenced by the extent to which the knowledge can be put into practice alongside other people, and by the extent to which the knowledge is in the collective interest of the group. These concepts have not always been of interest to researchers in the past.

Discussion

Collaborative research is currently politically and theoretically endorsed by feminists as both a way of conducting research into teacher development and as a means of teacher development. However, collaborative research methods are themselves problematic when the realities of practicising teachers and the potential number of teachers involved in teacher development in the area of girls and science are considered. We suggest that incorporating components of collaboration into a teacher development programme might be fruitful. Such components would be talking with and listening to other teachers; giving and getting ideas for new teaching activities; giving and receiving support and feedback; visiting the classrooms of other teachers and being visited in their own classrooms; inquiring into their practices and listening to students; and thinking about their concepts of *science education* and of *girls* and what they do in the classroom, both privately and publicly (Bell, 1993).

These components can result in teachers on a programme contributing as well as receiving; sharing roles with the facilitator; negotiating the content and direction of the programme; and being empowered to feel better about their teaching. We suggest that these components are emphasised in collaborative research but they can also be the basis of teacher development programmes in the area of girls and science.

Note

kaupapa	purposes, objectives
whanau	extended family

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Les filles et les sciences en harmonie : Un recueil de chansons «A CAPPELLA»

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ABRÉGÉ

Ce document, qui puise à plusieurs sources canadiennes de recherche sur la qualité de la vie des jeunes filles, a pour but d'amener une augmentation du taux de participation et de réussite des filles dans les sciences, les mathématiques et la technologie (SMT).

On y explique qu'en invoquant uniquement des arguments économiques pour appuyer les mesures visant l'amélioration des chances des jeunes filles dans les SMT, on fait abstraction des questions fondamentales que sont l'injustice et l'iniquité sociosexuelles, et on favorise des solutions étroites qui reposent sur la supposition que ce sont les jeunes filles elles-mêmes qui font problème. Une perspective globale et intégrée sur les questions rattachées à la qualité de la vie des jeunes filles s'impose si nous voulons apporter des changements plus efficaces et soutenus dans les écoles et dans les collectivités.

Au Canada, la Fédération canadienne des enseignantes et des enseignants a entrepris des recherches et a réalisé des projets conformément à ces buts. Dans plusieurs publications portant sur di.ers aspects de la vie des jeunes filles et des femmes, les membres de la profession enseignante et les décisionnaires ont été mis au défi de travailler avec les collectivités pour atteindre leurs buts communs. Les publications de la FCE sont décrites dans le document et seront offertes à la conférence. En particulier, les recommandations découlant du Cahier d'idées AMÉLIORÉ : Liens entre la catégorie de sexe, la culture, les sciences et les écoles feront l'objet de débats pendant la séance.

"A CAPPELLA"
Situating Science in the Reality of Girls' Lives

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ABSTRACT

This paper links several sources of Canadian research on the quality of girls' lives with the goal of improving the participation and success rates of female students in the study of Math, Science and Technology.

It argues that using exclusively economic arguments to support improved science and technology opportunities for women denies the root issues of gender-based injustice and inequity, and encourages narrow interventions which see young women themselves as "the problem" to be remediated. Only through a comprehensive and integrated understanding of quality-of-life issues for young women can more effective, sustained transformations within schools and communities be created.

In Canada, the Canadian Teachers' Federation has initiated research and project development consistent with these goals. In several publications on different aspects of girls' and women's lives, teachers and policy-makers have been challenged to work with communities towards common goals. These materials are described in the paper and will be available at the conference. In particular, recommendations from The Better Idea Book: A Resource on Gender, Culture, Science and Schools will be discussed during the session.

THE QUALITY OF GIRLS' LIVES

The quality of each girl's life is linked to the quality of all girls' lives. If the only purpose of engaging more young women in the study of Math, Science and Technology (MST) is to win macroeconomic battles, then consideration of the quality of girls' lives may not be pertinent. If the classroom is the only venue which needs to change, perhaps it is also irrelevant. But if instead participation and success in MST are encouraged because they will enrich girls' lives, then knowledge of their quality of life now is essential to effecting change.

Several recent major studies provide complimentary snapshots of adolescent girls in Canada. Knowledge of these characteristics, their relationship to each other and how they shape girls' math-science-technology (MST) attitudes and behaviours may well determine the effectiveness of innovations.

A CAPPELLA

A Cappella: A Report on the Realities, Concerns, Expectations and Barriers of Adolescent Women in Canada reported on the results of a participative research study designed and carried out by the Canadian Teachers' Federation (CTF) involving more than 1,000 girls aged 11-19 in conversations with each other and their teachers. Among its findings:

- Many girls based their self-esteem in their mastery of "people skills", and considered issues largely in terms of how others were affected by actions and events.
- Girls equated their growing sexuality with increased risk, vulnerability and hassles.
- Girls reported being very susceptible to the opinions of others. Discord, disapproval and criticism, especially of their capabilities or appearance, undermined feelings of self-worth.
- Most girls were fully aware of the likelihood that they would need to earn a living most of their lives. They tended to see this as an overwhelming "add-on" to maintaining relationships, caring for a family and negotiating an unfriendly world.
- Many girls indirectly yearned for "the evaded curriculum" when they criticized teachers and schools. The experience of "really talking" with a teacher seemed extraordinary and positive for both students and teachers.
- Many girls reported feeling greatly stressed by the competing priorities of family responsibilities, friendships, romantic relationships, part-time jobs and school work. Boys were not seen as having as much to worry about, or as taking life as seriously.
- Despite a strong sense of "unfairness" in the present, girls were unlikely to commit themselves to viewing the world of work they would inhabit some day as biased against women.

These implications and findings should inform MST strategies. For example, the frequently-voiced criticism of "irrelevancy" to describe the sciences should perhaps be heard as a critique of the curriculum's preferences for pulleys over people. Since self-esteem for girls requires that they are valued "for themselves", and not only for their capabilities as students, the classroom should provide opportunities for students to demonstrate people-skills as well as computational skills, and to have both credited. Our determination to refuse to tolerate hostile teasing and banter, particularly when it comes from male students, should be reinforced.

The focus of female-directed career discussions in the classroom, perhaps particularly in MST-driven programs, has been on career awareness, with an emphasis on the evaporation of knights on white horses and the severity of the female poverty rate. This message, although well-intentioned, seems to have frightened and disempowered young women more than it has motivated them to do well. Fearing they can't have it all, many seem resigned to having nothing. As they see their mothers struggling to balance conflicting priorities and, they report, see men and boys "getting off easy", many young women seem to be choosing not to play the game.

Ironically, in trying to convince young women that "they can be anything they want to be ", we may have substituted our desire for how we want the world to be for how it is. Believing that workplace and career equity exists "somewhere out there" could, perhaps, be empowering if it means that as they mature into young adults, girls will settle for no less than equal treatment. However, believing gender equity has been achieved can make one's own experience seem anomalous, and can turn experiences such as sexual harassment or a gender-motivated denial of promotion into events for which one is somehow personally responsible. Denial of systemic bias is not empowering; to tell a young woman that sexism no longer exists on construction sites or in higher education is to do her no favour.

Girls' resistance to feminist labels is a challenging issue. On the one hand, young women quite clearly want the goals of feminism to be achieved, but many are wary of being identified with the movement to achieve these goals. To be female seems "bad

enough" to some, to be visibly angry or resistant is to invite even more problems. This reluctance to "step out of line" may well be related to young women's frightening familiarity with violence. As Peter Jaffe points out:

> *"Violence or fear of violence is part of the daily reality of every Canadian girl. The violence may come in the form of sexism, racism, intimidation, physical abuse, sexual assault and verbal, emotional or psychological abuse. The violence is so much a part of the landscape that many girls suffer in silence and assume the violence is inevitable."*[1]

Sometimes the violence in girls' lives is directed towards them; often it is towards their mothers. Young girls who grow up witnessing violence are prone to significant emotional and behavioral problems. But girls are not just bystanders to violence: the Badgley Commission concluded that one in two girls would be sexually assaulted before they turned 18, usually by someone with whom they shared a "trust" relationship.[2] One in nine Canadian girls reports that she has been physically or sexually abused in a dating relationship,[3] and this is in a context where girls under-identify assault, preferring to shoulder blame for "letting him go too far" rather than naming assault and victimization for what they are.

The school's reluctance to deal with issues such as these prompted CTF's publication of Thumbs Down! A Classroom Response to Violence Towards Women in 1990.[4] This attempt to legitimize discussion of the "evaded curriculum" of girls' lives has been widely praised, but it seems to have been used more widely outside than inside schools. As denial of the prevalence of violence in girls' lives becomes harder to sustain, teachers, boards and ministries must address the validity of the rationale used to permit quadratic equations to have an entitlement within the curriculum which anti-violence education does not.

The research begun in A Cappella has lead to a number of important initiatives. CTF is currently designing and implementing a multi-facetted project intended to develop a network of committed and well-placed individuals within each province and territory. The networks will initiate school and community-based interventions to improve

the quality of girls' lives. Detailed background papers on the themes identified in A Cappella, including self-esteem, violence, career plans and the culture of schools are in preparation as part of this project.

WE'RE HERE; LISTEN TO US

In 1992, the Canadian Advisory Council on the Status of Women published the results of an extensive survey of 13 to 16 year-old male and female youth.[5] Among the results:

- Twice as many young women as young men said they didn't feel good about themselves.
- The gender gap in self-confidence increased with age.
- Almost one in five young women said they had been sexually abused.
- By age 16, 61% of young women said they were under great stress.
- Only 3% of young women didn't expect to finish high school.
- Ninety-four per cent of young women said doing well in school was important to them, but only 66% said they liked school.
- Sixty per cent of young women said they spent five or six hours a week doing homework, compared to 44% of young men.
- Girls identified both personal and global concerns with equal frequency when they described what they would change about the world.

These findings, together with the entire report, suggest that girls are highly motivated to succeed, but perhaps they are likely to avoid subjects which add disproportionately to their levels of stress, hours of homework, or which erode apparently fragile self-concepts. While selling MST as "tough but worth it" may improve the prestige of these courses, many girls, who despite ability tend to underestimate their own success at new tasks, may be discouraged and hear such descriptions not as a challenge but as a threat. Again, a more altruistic positioning of the potential of science to solve global and environmental problems rather than its instrumentally leading to prestigious career choices may better connect with young women's value systems.

THE HEALTH OF CANADA'S YOUTH

This 1992 publication[6] from the Government of Canada suggests that not only are Canadian girls at greater risk than boys on a number of health indicators, they are at greater risk than their international counterparts, and there is a measurable decline in their health status from ages eleven through thirteen and fifteen. Findings such as these ought to alarm all those interested in the quality of life of Canadian youth:

- The percentage of girls who believed their teachers thought their work was "very good" or "good" declined from 32% to 22% between the ages of 11 and 13. Boys registered only a 2% decline during the same period, from 22% to 20%.
- Girls at each of the age levels (11, 13, 15) were more likely than boys by an average of nine percentage points to agree there were one or several teachers they feared.
- Between 25% & 39% of boys and girls feared one or several students, with Canadian girls, by age 15, the most likely in the 7-country sample to admit they were frightened.
- For boys at ages 11 and 13, 74% agreed with the statement "I have confidence in myself". For 11 year-old girls, the percentage was 66%; by age 13 it had declined to 54%, a level which was only 2/3 of the score of boys of the same age.
- Forty-eight percent of 15 year-old females wanted to lose weight, compared with 19% of 15 year-old males.
- Fifty-eight per cent of 15 year-old females said they "often" or "sometimes" felt like outsiders. Both males and females, at every age level, were more likely than students from 9 other countries to say they "often" or "very often" felt lonely, with 15-year-old Canadian girls the most likely of all to say they were "very often lonely".
- Canadian girls at 15 were less likely than 15 year-old boys to say they felt understood by their parents, and were more likely to say they wanted to leave home, and were less likely to say they had a happy home life.
- At every age, Canadian students, male and female, were the least likely of those from 9 countries to agree that they could "talk to their fathers about things that really bother them." This effect is strongest in 15 year-old girls.

- At both ages 13 and 15 girls were two-and-one-half times as likely as boys to say they had felt depressed "often" in the previous six-month period.
- Eleven-year-old Canadian boys were five times more likely than girls to spend four or more hours per week playing computer games.

This research confirms the precipitous decline in self-esteem found to characterize girls between the ages of 11 and 13, a decline from which they do not recover. Girls perceived their teachers as being displeased by their work, and many were afraid of at least some teachers. Yet girls' sense of self-esteem is not drawn primarily from accomplishment but from appearance; girls' preoccupation with body image leads some to a fixation on dieting and weight loss; the consequences of such a fixation are not just physical and emotional but also intellectual. Naomi Wolfe claims that the majority of American college-age women have eating disorders of sufficient severity that powers of memory, concentration and ability to learn are actually impaired.

The mental health indicators of anxiety and depression girls reported raise questions about how gender stereotypes affect identification, intervention and treatment of emotional disturbance. The Ontario Child Health Study[7] found that teenage girls were the least likely of all students to be referred for counselling and psychological services. While it is true that disturbed young males tend to act-out and thus draw attention to their behaviour and emotional states, it appears that either our perception that depression is a natural state for young women, or else our lack of awareness of their state, contributes to routinely ignoring the misery many female students are experiencing. Since schools are prime health/psychological referral agents, it is necessary to be particularly vigilant in not allowing self-effacing girls who consider themselves "outsiders" to be overlooked.

In considering the contribution of the MST classroom to girls' quality of life, it is worth remembering Margaret Rossiter's observation that to be a female with an interest in science was to be doubly anomalous, doubly an outsider.[8] Girls' fear of being seen as "the other" may disincline them to take part in programs which are seen as unusual for girls, or to aspire to non-stereotypical careers. In a moving essay on girls' education, Emily Styles refers to curriculum, at its best, as providing both windows and

mirrors.[9] Mirrors allow one to see oneself, reflected, but also to see others like oneself who have achieved great things. Windows allow one to see the world as it is and as it might be. For too many girls, the mirrors of the curriculum do not offer familiar images or images of women achievers unless these women are labelled as exceptional. Worse still, neither teachers nor texts encourage students of either sex to reflect on why this might be so. The windows through which young women are allowed to look show someone else's idea of the best view; often there is only one view, one history, one path. The MST classroom must overcome a masculinist history through finding new mirrors and windows if it is to present young women with a glimpse of the possible.

Research such as the important American study "Shortchanging Girls, Shortchanging America" which directly addresses linkages across issues (i.e. linking oneself and liking math, science and technology) are valuable tools in helping teachings understand the complexity and implications of quality-of-life research.

Appreciation for mathematics/science appears to be reasonably well established in the elementary grades, but by high school it appears that for girls this affection becomes influenced more by perceptions of self rather than perceptions of mathematics and science. Girls seem difficult to convince that they can do something well unless they "like it", and unconvinced that even when they are successful (in terms of grades) that they are, in fact "good at" mathematics and science. For those for whom a breakthrough in a sense of efficacy as well as achievement can be made, there are enormous benefits in self-esteem and career confidence to be gained.

Unfortunately, it appears that when girls do well at a task (for example, score well on an exam) they tend to attribute their success to luck or hard work. When they do poorly, they end to internalize the responsibility, blaming themselves for not studying the right things or, often, to being not smart enough to do better. Conversely, boys tend to credit their personal ability (rather than effort) for success, and externalize blame for failure (for example, the test was too hard, the teacher didn't explain the work, etc.).[10] Thus praising a girl for success on an exam will not necessarily result in her benefitting from the compliment if she is internally dismissing her own role in the

achievement. Praise must be directed not only to accomplishment but to ability, expressed through high expectations and recognition of everyday competency in many domains.

The extent to which a better understanding of the quality of girls' lives can be blended creatively with MST initiatives will determine their success. While it is easier to segmentalize girls' MST attitudes and behaviours and attempt to address them without the additional complexities of health, violence, self-esteem and the evaded curriculum, interventions based on narrow definitions of "the problem" will be short-lived. If we are to be effective, we must be prepared to view girls' experiences both inside and outside the classroom more holistically.

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WOMEN-IN-AGRICULTURE PROGRAMME IN NIGERIA

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Ce document décrit la noble contribution des Nigériennes vivant en milieu rural dans le domaine de la production, du traitement, de l'utilisation et du marketing des produits alimentaires. Il souligne que le programme Women-In-Agriculture (WIA) des divers State Agricultural Development Projects (ADP) constitue un énorme progrès en vue d'aider les femmes qui vivent à la campagne à contribuer davantage à la production agricole, au développement national et à l'auto-réalisation. L'objectif d'unification des vulgarisatrices et vulgarisateurs dans le cadre de la diffusion de l'information par le biais des ADP est bon du fait de sa rentabilité, mais illustre la pénurie générale de vulgarisateurs, et plus particulièrement de vulgarisatrices. Ce phénomène a de sérieuses répercussions sur le programme WIA parce que la participation des femmes, malgré que les vulgarisatrices tentent toujours de l'encourager, risque d'être totalement ignorée. D'autre part, on remarque la lente évolution technologique dans certains domaines posant des problèmes à de nombreux agriculteurs et la nature monotone d'une technologie de production qui ne change pas. La plupart des vulgarisatrices et vulgarisateurs travaillent encore dans les domaines du traitement et de l'utilisation des produits alimentaires, principalement dans l'utilisation de la technologie des graines de soja, en vue d'accroître la nutrition et l'usage de la technologie disponible pour le traitement. Il est essentiel de produire plus de technologies et de fournir aux femmes des services de vulgarisation en production alimentaire, sur l'usage de diverses graines améliorées, de produits de fertilisation, sur la gestion du sol et la combinaison d'entreprises.

La solution immédiate idéale pour remédier au problème de la pénurie de vulgarisatrices est l'expansion des cellules où travaillent les vulgarisatrices et vulgarisateurs et le recours à l'approche de groupe, plutôt qu'à l'approche individuelle, pour diffuser l'information. Ce document dresse également une liste de solutions à d'autres problèmes.

WOMEN IN-AGRICULTURE PROGRAMME IN NIGERIA

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ABSTRACT

The paper reiterates the noble contribution of Nigerian rural women to food production, processing, utilization and marketing. It observes that the Women-In-Agriculture (WIA) programme of the various State Agricultural Development Projects (ADPs) is a giant stride to assist rural women in enhancing their contribution to agricultural production, national development and self-actualization. The pursuit of unified extension in information dissemination by the ADPs is good because of its cost effectiveness. It however, notes the general shortage of extension agents (EAs) particularly women EAs. This has implication for WIA programme because women interaction aside from being better promoted by female EAs may be completely left out. Further, it notes the slow pace of technology generation as evidenced by numerous farmers' problems and the repetitive nature of the same production technology. Most activities of the EAs are still in food processing and utilization, mainly the use of soya bean technology to improve nutrition. Food processing also focuses on improving "gari" quality. There is need to generate more technologies and carry out extension services in food production to women on use of improved seed varieties, use of fertilizer, soil management and enterprise combination.

The immediate solution proferred for shortage of female EAs is expansion of the cell sizes where EAs work and the use of group contact as against individual farmer approach in information dissemination.

INTRODUCTION

Nigeria, the most populous nation in Africa, has agriculture as the main occupation of the citizenry. Rural women like men are engaged in agriculture. The women constitute more than 50 percent of total agricultural labour force. They engage in agricultural activities which include crop production, livestock rearing, fishing, agro-

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Les soumissions - Colloque international GASAT 7, Canada, 1993

processing, food utilization, storage, and marketing.

They produce maize, cassava, yam, rice, leavy and fruit vegetables in mixed cropping systems geared towards boosing land productivity while at the same time ensuring that a wide range of food is made available for home consumption. Women mostly undertake farm operations like planting, weeding and harvesting. In addition to these, they have demonstrated intellectual talent in childcare, nutrition and health care of household members (Adegeye, 1988).

In the rural communities, women engage in processing of agricultural commodities using crude traditional methods with low efficiency and high level of drudgecy. For example, cassava is processed to 'gari', 'fufu' and cassava flour. Maize is processed to 'eko'. Rice is parboiled, milled and packaged. Yam is processed to yam flour with greater shelve life. All these are later sold in markets together with other farm produce.

Markets are usually not in immediate vicinity and this couple with poor transport system compel them to trek long distances. Lack of alternative non-agricultural employment opportunities have made them to hold tenaciously to agriculture. More-over, the lack of support facilities that would free them of their chores denies them leisure.

In recognition of the important roles women play in agriculture, policies and programmes are now in place to assist women in agriculture to increase production and reduce the drudgery faced by them. For example, Lagos plan of Action for Africa (1980) emphasizes the action of government in encouraging rural women to increase food production, reduce food importation and reduce rural migration (FAO, 1984). The plan of action stressed

vigorously:

- the need for government to recognise the significance of rural women in food production and therefore improve their skill while making women's labour less strenous.
- the need to initiate and sustain continuous research on the strengthening and documentation machinery for recording contributions of women to agriculture, particularly with regard to food supply.
- the need to establish and strengthen women's division in Ministries of Planning so as to integrate the programme into a national plan of action.

One of these programmes to assist women is the Women-In-Agriculture (WIA) component of the Agricultural Development Projects (ADPs).

IMPLEMENTATION OF W.I.A. IN THE ADP SYSTEM

In Nigeria the ADPs are the extension arm of the State Ministries of Agriculture and Natural Resources (SMANR) charged with dissemination of innovations to farmers. The ADPs have been mandated to have a WIA, Component, specifically for gender-specific improvements. The ADPs came into existence in 1975 while the WIA programme was born in 1986 at the instance of The World Bank.

Initially, ADPs' extension focus was crop-based using the Training and Visit (T & V) system of extension. Currently, however, the extension focus has been expanded to cover all other agricultural sub-sectors, thereby putting in a place a unified agricultural extension system (UAES). This involves transfer of technology in all subsectors of agriculture by a single Extension Agent (EA) under the ADP umbrella.

Using deployment of key staff to man various agricultural subsectors,

noticeable progress has been made in establishing WIA programmes in the states of the Federation. FACU (1992) reported that except for Yobe State, staff are in position for WIA programme in the Federal Capital Territory and 29 out of 30 States.
The Agricultural Development Projects (ADPs) have their WIA component in the technical and extension components. This pre-supposed proper planning of the WIA activities. Figure I gives the organogram of the ADP system and the position of WIA in the project.

OBSTACLES AND ACHIEVEMENTS OF WIA

The WIA programme though relatively young in the ADP system is already experiencing some handicaps. Generally, the unified agricultural extension system (UAES) as practised under the T & V approach is predicated on the number and competence of the extension staff particularly the EAs and the competence of the subject matter specialists (SMSs). Under the T & V system, each EA is expected to serve about 800-1500 farm families and this works out at about 300-700 EAs per state, (FACU, 1992). This is quite a large complement of staff which most States have found difficult to provide. The picture is even more blurred with respect to women extension agent's requirement. Dissemination of innovation to rural women farmers is more likely to be embraced better when undertaken by women EAs. The shortage of women extension agents needs immediate redress for successful WIA programme. Further, the SMSs are hardly specialists. Most of them are Higher National Diploma holders with little or no experience in research, and have to occupy positions meant for at least M.Sc. holders. The result is such that SMSs have no sufficient expertise to appreciate and or modify recommendations to meet specific local requirement. (Ilevbaoje et al. 1992).

Presently, the major emphasis of women EAs are on food processing and utilization. The major technologies demonstrated are in areas of utilization of Soya beans to improve domestic nutrition. The use of motorised engine in grating cassava in processing of 'gari' is slowly gaining ground. As important as these are, they should not be done to the detriment of dissemination of innovation in direct agricultural production, farming being the main occupation in the rural areas. Women groups should be encouraged to spring up and group contact approach used to teach and train the women in improved crop production techniques, using improved seed varieties, fertiliser, correct spacing and enterprise combination, given the shortage of women EAs.

The expansion and diversification of the household economic activities have increased work burden of women. Social services and access to medical facilities are still poor in the rural areas with the consequences on the well-being of women. The lack of adequate infrastructural facilities like good roads, pipe borne water, alternative energy source other than firewood, markets and poor transportation system mean women have to face considerable drudgery in their day-to-day activities.

There is low pace of technology generation in the ADPs as shown by numerous unresolved problems and the repetitive nature of the production recommendation. Appropriate technologies are required to address the problem of storage, processing and marketing agricultural products relevant to the various ecologies and social groups in different locations in Nigeria, (FACU, 1992). This will encourage all season availability of agricultural products, stable prices and encourage greater production.

The implementation of WIA programme could be constrained by the

absence of appropriate manpower, basic technical and institutional facilities for technology development and dissemination. These include facilities for extension, research, skill development and training.

SUGGESTED SOLUTIONS

There is need for greater manpower development of female extension agents and SMSs if the challenge of WIA programme is to be met. In the interim greater innovation dissemination can be achieved by expanding the cell sizes of ADPs now in use coupled with group contact extension instead of contact farmer approach. The EAs have to be monitored to ensure that they use UAEs in innovation dissemination. They must be trained and re-trained to imbibe the UAEs ideology given its cost effectiveness and the immediate solution offered to manpower shortage.

Research to improve the pace of innovation generation must be in all areas of production, be it direct food production, processing, and utilisation and marketing of agricultural commodities. This is one solution to the encroachment on the women leisure time.

There is need for greater provision of infrastructural facilities in the rural areas. Good road network, transport, pipe borne water, rural electrification, rural markets, alternative energy to firewood are inevitable and should be pursued with result oriented vigour.

Women groups need to be fostered and linked with financial institutions so as to source funds required for their operations.

Cooperative Societies should be promoted among the women.

CONCLUSION

The WIA component of the ADP system has a lot of challenges ahead in order to address the age-long obstacles faced by rural women. The executors of the programme should leave no stone untouched as spelt out in the objectives for the WIA programme. The objectives are complementary and a holistic approach should be used in their pursuit. It is in so doing that the goal of women empowerment and emancipation can be achieved.

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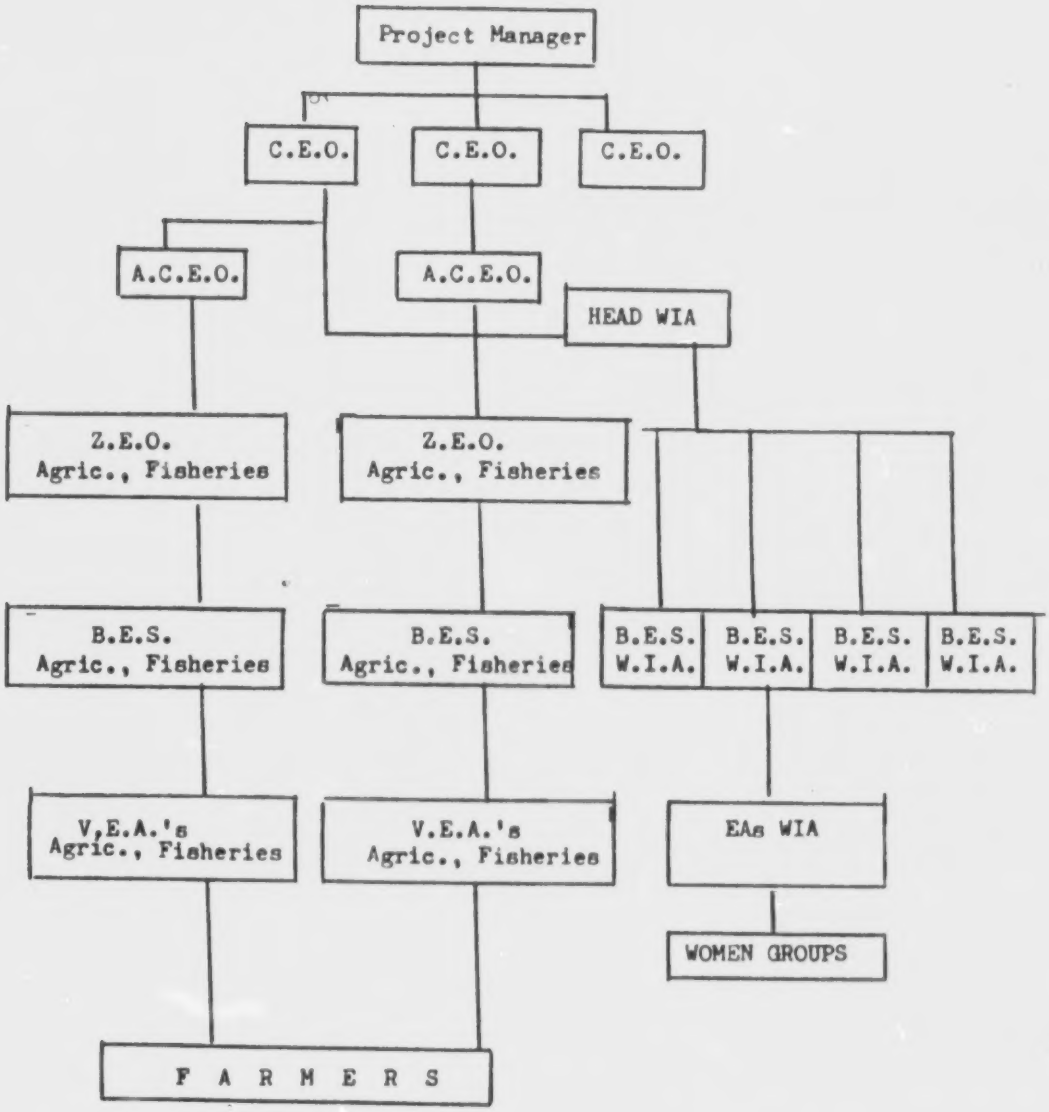

Figure I: Organogram showing the position of WIA programmes in the ADP system.

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DEVELOPING A WOMEN'S COMPUTER NETWORK

Norma Dogger and Marilyn Dickson

Il y a dix ans, la Federation of Women Teachers' Associations of Ontario (l'organisme professionnel qui regroupe les enseignantes des écoles élémentaires de l'Ontario) a mis sur pied un programme unique visant à promouvoir l'égalité des sexes dans le domaine de l'informatique. Nous étions d'avis que si les enseignantes en savaient davantage et étaient plus à l'aise avec les ordinateurs, les étudiantes seraient alors en mesure de développer une confiance similaire à l'égard de ces appareils.

Ce document décrit le programme sous deux angles différents -- les buts et l'organisation du programme, d'un point de vue provincial, et l'expérience d'une enseignante durant et apres le cours.

DEVELOPING A WOMEN'S COMPUTER NETWORK

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and

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Federation of Women Teachers' Associations of Ontario

ABSTRACT

Ten years ago the Federation of Women Teachers' Associations of Ontario (the professional organization of elementary school women teachers), Ten years ago the Federation of Women Teachers' Associations of Ontario (Canada) developed a unique program to promote gender equity in the use of computers. We believed that if women teachers became more knowledgeable and comfortable working with computers, female students would develop a similar confident attitude towards computers.

This paper describes the program from two points of view - the course purposes and organization from the provincial perspective, as well as the experience of one teacher during and after the course.

At the Fifth World Conference on Computer in Education 1990 in Sydney, Australia, it became quite evident that several concerns with regard to teacher education are world-wide. They mainly centered around pre-service and in-service education. Although a start has been made at educating teachers to integrate the computer into the curriculum, much still remains to be done. During many of the seminars that Norma attended at the Australian Conference, she heard echoes of the problems currently facing

Ontario school boards. Presenters from all over the world revealed their concerns about the three main issues regarding the provision of in-service programs for teachers:

1. Time - When is this professional development to be done?

2. Money - Who is going to pay for it?

3. Instructors - Who is going to do the in-servicing?

Too frequently the initial or pre-service training of teachers has not been or is not being properly addressed. Many newly qualified teachers are emerging with very little knowledge about educational computing. A survey of computer use in Ontario Faculties of Education conducted by Curt Dudley-Marling and George Tracz in 1988 revealed that about half of the Faculties offer computer awareness courses ranging from 12 hours to 38 hours of work. Some of these courses are required and some are voluntary. The usual reason for not requiring these courses was not having room in the curriculum for them! Where the courses were voluntary between one-half and two-thirds of the student-teachers were taking them. Another approach at pre-service level was to include computer-awareness into existing courses providing 5-6 hours on computers, hardly enough to be able to use computers effectively in the classroom.

According to C.W.N. Carr, who has worked on several task forces for the Toronto, Ontario, Board of Education, "Any task force responsible for designing an in-service program should be led by a professional leader with group management skills who is experienced in management thinking processes, situation assessment and decision analysis."

Ten years ago the Federation of Women Teachers' Associations of Ontario (Canada) developed a unique program to help women teachers become more knowledgeable and comfortable working with computers. Their students now use computers as powerful learning tools.

In the early 1980's Ontario teachers were beginning to use computers in their classrooms. The Ministry of Education first sponsored computer courses in 1982. The

courses were taught predominantly by secondary computer science teachers although most teachers attending the courses taught in elementary schools. Unfortunately these early courses focused on programming and learning about computers, rather than on the curriculum. Most of these teachers were men.

At that time in Ontario most of the computers in secondary schools were in computer labs and were used for computer science classes. When elementary schools managed to get one or two computers, they were usually given to the intermediate teachers, teachers of the oldest students in the schools. These teachers were mainly men. There was a very real danger of computer education becoming a male domain.

The Federation of Women Teachers' Associations of Ontario is the professional organization (union) of the 42,000 women who teach in Ontario's elementary public schools. As an organization we have long been concerned about women's issues and in trying to eliminate gender stereotyping for both students and teachers within the schools as well as in society. Since our beginnings seventy-five years ago, we have applied considerable financial and human resources to achieving this goal.

Thus, when computers began to be introduced in Ontario schools as described above, we could see the genesis of a serious problem, one which of course would affect our members if they wanted equal access to computers, as many of them did. An even more serious problem though was what this would do to the female students in the schools. Already huge inequities were developing as boys gravitated to video arcades where they quickly became comfortable with this new technology. Women teachers were concerned about the militaristic attitudes which were developing as boys honed their skills at shooting down the targets on the screen, in much the same way that Major Schwarzkopf has demonstrated in the media as night after night he and his colleagues gloated over their surgical strikes in Iraq. Computer clubs were quickly becoming male domains, as were optional computer courses.

Women teachers were concerned about girls not having equal access to this technology. The seriousness of the situation became apparent to me during that year when I was taking one of the ministry sponsored courses for teachers. There were not

enough computers for everyone in class. Night after night I observed that each of the men in the class, who were in the majority, managed to get a computer of his own whereas we women were left to share one computer among every two or three of us. As a result, some women got very little hands on experience during the course. Few of us had access to one in our own work situations. It was somewhat like taking piano lessons without having a piano on which to practise.

When we weren't doing hands on programming activities, we gave class presentations about computer use in society. A colleague of mine who also worked for the federation was taking the course as well. We had agreed to do a presentation together and considered various possibilities. She convinced me that as employees of the women teachers' federation we had a responsibility to give our presentation on gender issues related to computers. I willingly agreed to her suggestion even though I had had different ideas about what we might do.

The night of our presentation the need for presentations such as ours became dramatically evident. We began by inviting some audience participation. No one offered any comments. As we continued, the men, including the instructor, began to talk and joke among themselves. Most of the women sat in silence, although even a couple of them joined the men in trying to divert attention from us. Following our presentation no one spoke to us for the rest of the evening, not even during the break. People who other weeks had held the door for my friend because of her broken leg, or who on other occasions had inquired about her leg, that night avoided us like the plague. During the following weeks they were friendlier towards us although a slight strain still existed. No one ever mentioned our presentation, at least not to us.

I clearly understood now that the federation needed to do something in the area of computer education, for our own members as well as for the female students in our schools. We could no longer allow men to take over the computer domain. We needed to get as many women teacher as possible working with computers and becoming good role models for girls. We also needed women's voices influencing how computers would be used in schools.

We developed a program to teach a small group of teachers each year to give courses for other teachers. The course had three main goals,

- to increase computer competence with a variety of computers so that participants would feel comfortable teaching courses on any of the computers commonly used in schools,

- to develop a philosophy about the best use of computers in schools, and

- to develop confidence and competence in teaching adults how to use computers.

In order to take the course, teachers needed to be able to use one kind of computer. We were fairly flexible about what this meant in terms of paper qualifications. Basically we wanted people who felt comfortable with a computer. We believed that if they had this confidence they could readily learn to feel comfortable with other computers as well.

We expected them to give the course a high priority for one school year and to make a commitment to teach at least two subsequent courses for the federation. We asked their school boards to provide them with at least one computer in their classroom during the year they took the course. To us, this demonstrated the board's support for the teacher as someone who had the potential to be a good workshop leader. It also gave women teachers visibility within their boards and acknowledged their competence with computers.

The federation made a significant commitment to the participants by paying for their release time from teaching duties for six Fridays during the year. As well, because the federation believes in equal opportunity for our members to participate in federation activities and because Ontario is so large geographically, we paid the travel expenses for everyone taking the course. We also paid the majority of accommodation costs, although

each participant contributed to this cost. Each year the federation committed about $150,000 for the course for a maximum of 20 teachers. The participants themselves paid about $1,000 (including the course fee and accommodation subsidy), which was reimbursed to them after they subsequently taught two computer courses for other teachers.

The course itself included a one week period in August with three sessions a day, plus six three day weekends during the school year, beginning on Thursday evening and finishing on Sunday morning. These weekends were spread throughout the year about five or six weeks apart. Participants would go back to their schools and work on what they had learned one weekend and then come together again to discuss their experiences and questions before moving on to something else. The residential aspect of the course created a wonderful opportunity for networking and the participants became good support groups for each other.

During the August week we focused on teambuilding, effective communication, and improving the participants' competencies with a variety of computers. Participants worked primarily on computers with which they were not familiar. Our goal was that by the end of the week they would feel reasonably comfortable working on all computers commonly used in Ontario schools. At the same time we wanted them to go back to the beginner stage with a computer so they would better understand what their teacher students would be going through when they began teaching computer courses. Participants were encouraged to keep journals during this week in particular so they would readily recall their learning experiences.

After that first week in August the focus shifted from the computer to curriculum. During recent years the first of the six weekends focused on the various areas of the curriculum such as language arts, social sciences, and the arts. As well, there were sessions on curriculum development and on gender equity. During the later weekends the focus shifted again, to using computers in integrated programs and developing the courses where these participants would then teach other teachers. The course has evolved since it began, as we continued to learn more about computers and to refine our own views about how they should be used in schools.

Because many of the graduates continued to give courses for the next few years, and because things were changing so quickly in the computer field, there was a need for them to keep current. Once a year the graduates were invited to come together for what I termed a "micro conference", where they shared what they were doing and what they had been learning. In addition to the participants' workshops we also had one or two outside speakers who were in the forefront of computer education.

Graduates of this provincial course then went on to teach introductory and second level computer courses to other women teachers. Since the courses began, the seventy-eight graduates of the provincial course have taught nearly two hundred other courses around the province. As well, several have taught courses and given workshops through universities, their school boards, or other groups. Some have become computer consultants, resource teachers or vice principals and principals within their own boards. Others have served on their boards' committees to develop policy and make other decisions about computer education. Some have developed software or have written articles about computer education. Their influence continues to be felt throughout the province. This is a tribute to the commitment of many women teachers to their students and colleagues.

According to Norma, being involved in the FWTAO Provincial Computer Course has offered tremendous rewards for professional development and personal growth. She believes the greatest benefits gained include

- knowledge and skills for operating and maintaining various kinds of computers. This was the first opportunity I ever had for totally dismantling and reassembling a networked system. The numerous technical trouble-shooting pointers learned during our sessions have proven invaluable over the years, not only for keeping the computer systems humming during our regular teaching assignments but also while teaching courses. As anyone who has ever worked with a computer knows, Murphy's Law certainly applies - whatever can go wrong will, at some time or other!

- improved confidence for speaking before adults. This steadily developed during the course. For example, everyone had to take her turn at reporting to the whole group the results from numerous small group discussions and activities. Every time we met again, each participant shared what she had been doing with her own or someone else's class during the interval we had been apart. We had many discussions where the participants had the chance to ask questions, to voice concerns and opinions, and to share experiences. The "after-hours" socializing proved very valuable too, for networking and gaining ideas from our colleagues around the province). One assignment was to give a presentation on sex equity to parents or fellow teachers, and then report back to the provincial group. Our biggest assignment was to plan an integrated unit which included a computer component.

- an understanding of political process as we offered input to the Ministry of Education regarding philosophy and policy for computers in education.

- skills and strategies acquired for teaching adult learners - differences between child (pedagogy) and adult (androgogy) learning.

- the sense of ownership and commitment because of our personal involvement in developing or revising and updating the courses we taught in the regional sessions.

The women who took our courses were classroom teachers from all divisions, kindergarten to grade eight, principals, vice principals, and consultants. Experience with computers ranged from those who knew absolutely nothing and exhibited a great deal of initial inhibition, to one woman who had already published several books for both children and adult beginning computer-users. (She was very interested in learning more about our federation's philosophy of computer use in education and about its input regarding the Ministry of Education's recommendations and policies.)

The fact that the course instructors were women teachers from the elementary setting created a supportive atmosphere for these female adult learners. Over the years

I have observed hesitancy, fear, and feelings of intimidation among many women when contemplating doing computer courses with men.

By using collaborative strategies in teaching the regional courses we helped teachers see how their roles in the classroom are gradually changing from being "sages on the stage" to "guides on the side" or facilitators of learning. It was important for them to overcome their concerns about students knowing as much as, if not more, than they did about computers. They came to realize that students and teachers learning together can be very positive experiences for all.

There were many opportunities for course participants to acknowledge and celebrate their progress during the course. Networking with women teachers from other parts of their school system or province was extremely beneficial too because of the exchange of educational concerns and ideas.

It has been very rewarding, as a course instructor, to see graduates of these courses going on to become computer-lead teachers or site-administrators in their own schools, taking university courses about computers in the classroom, attending and presenting at computer conferences, and even going on to take the FWTAO Provincial Computer Course so that they in turn might further help other female colleagues to incorporate this new innovation into their teaching!

THE RECRUITING AND TRAINING OF FEMALE VETERAN SOLDIERS TOWARDS CAREERS IN TECHNOLOGY

Yael Rom

Le projet présenté est l'un des *Na'ale Intervention Programs* conçus et mis en oeuvre par Idor en Israël depuis 1987, visant à accroître la participation des femmes dans le secteur du génie et de la technologie.

Le *programme Na'ale pour les anciennes combattantes* a été conçu en vertu d'un contrat avec le ministère du Travail et du Bien-être social. Étant donné que ce programme visait à réduire le taux de chômage parmi les femmes, les anciennes combattantes ont semblé être le groupe idéal. Des programmes de formation et de counseling professionnels et pédagogiques faisant la promotion des carrières en technologie ont été offerts.

Ce document décrit et parle de la méthodologie à laquelle nous avons eu recours pour concevoir le programme d'intervention, aborder les questions, les problèmes et les solutions.

Bien que le programme ait été conçu et mis en oeuvre en Israël, où les femmes doivent, de par la loi, servir dans l'armée pendant au moins 24 mois, les questions soulevées sont tout aussi pertinentes dans d'autres pays où un nombre toujours croissant de femmes se portent volontaires pour le service militaire et, en temps voulu, deviennent des anciennes combattantes.

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THE RECRUITING AND TRAINING OF FEMALE VETERAN SOLDIERS TOWARDS CAREERS IN TECHNOLOGY

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ABSTRACT

The project presented is one of the *Na'ale Intervention Programs* designed and implemented by Idor in Israel since 1987, in order to increase the participation of women in engineering and technology.

The *Na'ale Program for Female Veterans* was designed under contract with the Ministry of Labor & Welfare. Aiming to decrease unemployment among women, female veterans were preferred as the optimal population. Educational and vocational counseling and training programs towards careers in technology were offered.

The paper will describe and discuss the methodology we used while designing the Intervention Program, pinpoint issues, problems and solutions.

Although the program has been designed and implemented in Israel, where women are required by law to serve in the army at least 24 months, the issues raised are also relevant in countries where growing numbers of women volunteer for military service, and in time become veterans.

INTRODUCTION

In Israel, rates of unemployment are high and growing: in 1992 the unemployment rates were 8.3% for men and 14.0% for women, as compared to aproximately 9 and 11 in 1990. Among the unemployed, the rates among veteran soldiers – male and female – were even higher.

The average level of education of women in Israel is higher than that of men but their career choice patterns are still very conservative and follow mostly those of their mothers': nursing, teaching (from nursery schools to university) vocational guidance, counselling, social work, secretarial, etc. During the last decade we can see slight changes where the trend is mostly towards more careers in business and marketing.

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Les soumissions - Colloque international GASAT 7, Canada, 1993

In Israel, as in many other technologically developed countries, there is high demand for well trained and better educated personnel in specific vocations, trades and professions - mainly in Hi-Tech industries and related services. The demand for qualified personnel states also the various levels - R&D, Management, Production, Marketing, Maintenance. The high, and growing, demand for personnel with Hi-Tech potential, has created gender-biased placement problems, since comparatively few women have the prerequisites needed as advertised. Very few women have chosen to invest their personal resources in studying engineering (11%) and physical sciences or, during their secondary education, picked majors in science (15%) or technology tracks (less than 10%), that could, in time, enable them to apply for these job openings.

Unemployment of women polarized 2 groups:

1. university graduates;
2. women with 8-12 years' education (or less), who are usually placed in non-skilled low paying jobs and/or seasonal jobs.

A-priori it was quite clear that any intervention program contracted by the Ministry of Labour should target its efforts towards the women in the second group, in order to enhance their chances to break away from low SES by getting better paying and more permanent jobs.

METHODOLOGY

The Ministry of Labor and Welfare (the Women's Bureau) contracted Idor Science & Technology Ltd. to plan an intervention program; then, upon approval by a steering committee, to help the staff of the Women's Bureau to implement it.

Idor started work by posing the first set of questions:

What is the available data on employed vis-a-vis unemployed women, by age and economic branch? What are the Ministry of Labor's formal services doing for unemployed women? For unemployed men? What age group, among the unemployed, would provide best and/or optimal results? Short range and long range? What should be the framework for the intervention program?

Analysis of available data, pragmatic evaluations of the feasibility and the probability of success of an intervention program, as well as the success of previous intervention programs were discussed. The resolution was that the ntervention program should be designed for female veterans, 20 - 25 yrs. old.

The reasoning is as follows:

Unemployment - they suffer from a very high rate of unemployment;

Budget - they bring their own budget with them: they are entitled, by law and at government expense, to vocational guidance and counselling services, 10-12 months' training programs with pay and only 10% tuition fees;

Privileges for veteran soldiers hold for 3 years after discharge;

Access - veterans constitute 75 - 80% of the yearly female cohort and they can be easily reached through army channels.

Timing - Young people in Israel tend to postpone career choice decisions to "after discharge", sometime taking a year off to unwind, to travel, to work, to save money, etc.

Although the availability of personal scholarship and easy access tipped the scales of decision, the long range view of the Ministry was that investing in the young women would have better and more far-reaching benefits: better education and higher income in young families.

AIMS AND OBJECTIVES

The main aim was ***to encourage young female veteran soldiers to seek employment and training in technology-rich economic branches***

In order to achieve this aim and ensure its success we defined 4 major objectives, and planned to work on and at them simultaneously: success of the Program depended on the successful achievement of the 4 objectives:

1. Research and developement of new and more relevant courses and training program that would appeal to women;
2. Increasing awareness of female veterans to the national services available to veterans and encouraging them to utilise these for their own benefits;

3. Development of a program for the screening, guidance and follow-up counselling for female veterans towards careers in technology and in technology-rich economic branches;
4. Development of support services for female veterans during their study and training periods, as well as during first placements and adjustment periods.

DESIGNING THE INTERVENTION PROGRAM

1. Research and development of new and more relevant courses and training programs that would appeal to women

Analysis of lists of courses and training programs, participation breakdown by sex, marketing methods of the training programs and the information disseminated brought the following conclusions:

a. More opportunities are offered to men than to women;
b. Sex-biased information is subtly broadcast through the lists of courses published in the booklets and brochures handed to veterans.
c. Women could try for the more sought after programs – but are discouraged by descriptions of hardships during training and the future workplace environments and life styles.

We have therefore decided to:

1. screen the vocations in high demand;
2. examine the probability of succesful placements for women with these vocations;
3. examine the training programs and curricula for these vocations;
4. examine the schools and institutes providing training, especially their academic and social support services;
5. examine and identify the reasons why women avoided these vocations and places of study and training.

Our conclusions at the end of this stage were that:
Electronics (to date only 6.9% female participation), and Management (already close to 30% females) would be best suited for our purposes, both for a 2-year technical college level program and a 6-8 month training program.

In order to get women to register for these courses we had to devise a more appealing program that would cater to their perception of "a good vocation", hoping to copy the spectacular phenomena of 75% in medical electronics!

A special subcommittee of the curriculum development division at the National Institute of Technological Training examined our recommendations, the existing curriculum and future needs in the field, and came up with 4 new programs: a diploma of an Electronics Technician with 4 sub-titles in: Quality Control / Management / Marketing and Clients' Instruction / Technical Writing & Editing.

Two community colleges were selected for the implementation of the 2 year study programs; 3 vocational training centers were chosen for the 6-8 months training programs in electrical appliances, television electronics and C.N.C.

2. Increasing awareness of national services available to female veterans

Through interviews and analysis of participation rates in training programs and the use of other services we arrived at conclusions similar somewhat to those found in the U.S.: women veterans tend to perceive "veterans" and "veterans' privileges" as exclusive to male veterans, especially wounded veterans. They avoid using these services for their own benefit, as if "we had not earned" them. Israeli female veterans "let pass" learning and training opportunities, applied less for special loans, used less placements' referrals, etc.

It was obvious that in trying to change this pattern we will have to devise a way by which a larger segment of the female veterans would be exposed to a large variety of veterans' privileges, especially the process of career choice decisions, weighing and evaluating the vocations offered.

As mentioned before, 75-80% of the female cohort serve in the army for approximately 24 months; 60% serve in non-traditional vocations. A large proportion has achieved Full Matriculation and "already know" that they will

apply for academic studies. Our interest lies with those who do not stand a chance of being accepted to universities. Towards these young women we directed our efforts, trying to sell them the importance of investing time in the suggested procedures that would inevitably help them choose a career/a vocation/a trade.

We prepared well designed brochures using light colours, photos of women at work stations, and texts that would appeal to young women. Posters with similar photos and texts were sent across the country to be hung in all Placement Service Offices. Special information packets were sent to the target population.

Our aim was to take the women through several stages of growing awareness of the opportunities the Program offered, the challenge of interest and the possibility of steady employment in an ecologically clean environment with good pay and possible upward mobility. Each soldier who received the packet, could participate in an orientation day, visit a technical college and an industrial plant, talk to role models – women working in a wide range of jobs.

We have also run workshops for vocational counselors and placements officers of the Ministry, aiming to educate them to become promoters of the Intervention Program, and enthusiastic supporters of Women in Technology projects.

3. Screening, guidance and follow-up counselling towards careers in technology and technology-rich vocations.

A. Defining Criteria – The main problem in planning and achieving this objective was how to define the characteristic of the soldiers most likely to say: a) YES to our call to participate in the orientation days; b) eventually get sold on the idea that **technology is for me**.

We thought of "coping women", who will tend to take in stride any new and different job offer, and will be both stubborn and open minded enough to learn – weigh – decide and then go for it, putting in their best efforts. We assumed that they will be able to behave this way because they were pragmatic and aware of personal and family constraints, but have confidence in their ability to cope

successfully in jobs and assignements similar to those they encountered during their army service. "Talking" to the computer – holding the Total Personnel and Vocations Roster – we called for the following:

a. Female soldiers with 6 months to go before discharge;
b. 11–12 years' schooling, preferably with majors in technology;
c. had served in (.... a list of vocations), in technology–rich units, or had actually been trained as technicians;
d. had been exposed or actually worked in computer assisted/controlled services.
e. held officer's or N.C.O. rank and/or worked as instructor, and therefore had experience in working alongside men and sometimes in charge of them.

B. Outreach: – The Army Personnel computer came up with 6,000 names and information kits were sent to all of them to their home addresses – so they could share it with the families.

C. Orientation days were organised in 3 districts, in either a college or a vocational training center, and were scheduled for 6 hours. The soldiers listened to general lectures on current trends in the Civil Labour Force vocations in high demand, veterans' privileges scope and duration, placement services, study and training programs and the special Intervention Program. Two hours were planned for aptitude tests in order to diagnose vocational trends and encourage only capable women to choose technical vocations.

D. The Preparatory – The soldiers recommended to study technology, would be invited to a short (2–4 weeks) preparatory course, to get better acquainted with the 2 years study program, curriculum's pre–requisites and more visits in industry. The 2–4 weeks' preparatory was designed to include basic studies in maths, physics, english and Hebrew as well as tests to prove basic abilities and motivation. The veterans were to receive optimal study conditions: tuition, room and board, minimum–wage salary, tutorials and counselling. We wanted to weed–out the potential drop–outs as soon as possible and hoped to achieve 85% success.

E. Studies - During the 2 yrs. studies and the 6-8 months training, tutorials and educational counseling are provided. Field trips to visit industrial sites, as well as in-service training periods have been worked into the curriculum - all intended to familiarise students with future work-place situations.

F. Follow-up Counselling - Measuring achievements and outputs at every stage is necessary in order to evaluate correctly the effectiveness of the Intervention Program, reshape inputs, etc. Counselling during studies is important to all students. Counselling a minority group may be critical. Transferring women into non-traditional vocations needs cautious counselling and the right kind of withdrawal, so they would be ready for placement on graduation.

4. Support services during studies and training, and during placement of first job

The success of the Project will be determined according to the percentage of women finding placement in jobs with technical prerequisites.

This is the crucial question and towards this end the whole program was planned. Women are good at studying, but going on into the workplace where they are a minority, have no helping hand and sometimes are even harassed, they face a real problem. Without support they may decide to drop out despite their big investment up till now. The most critical time is the first day and the first couple of weeks at the work-place. Being new, fresh out of school is bad enough; being the only woman, or luckily two, puts the female newcomer at the mercy of everybody. Without positive feedback on how well she does at the work-station she may regress, perform poorly and loose her job because of performance levels.

Having a local mentor or a support program, organised by a vocational counselor is very important. The counselor can initiate feedback meetings for her with the foreman, or may set together a bi-weekly meeting with other women, or with former graduates of the same school who work in other places. Withdrawal

can be accomplished gradually, when the new worker feels well and accepted by co-workers, foreman and employer.

IMPLEMENTATION OUTSIDE ISRAEL

Compulsory military service in Israel has become the most influecial agent of social change for all our 18 year olds, but especially so for youngsters from low SES and for women. The service enabled them to try out their capabilities in non-traditional jobs and assignments, and in our program we made use of this breakthrough.

We assume that in other countries where military service is voluntary most of the young people join the armed forces either for the adventure or for economic reasons: the armed forces offer better opportunities for careers or for just making a living. In the U.S. at least the pattern has been as stated above.

The main issues are: *Who are the women who join the army as volunteers? Have the armed forces developed contingecy plans for women veterans when going back into the civil labour force? Will they be able to find employment, join a union, get credit and seniority for years' work while in the armed forces? Will they use to advantage their veterans privileges - hospital care, loans, mortgages, studies, etc.*

Very little is actually known and even less has been done for some of them.

Yes, I think the Israeli model and its line of questioning and reasoning can be used to plan intervention programs for veteran women abroad.

Idor started work on the Intervention Programm in July 1990. By July 1991 the Program was launched, with actual training starting in the Fall of 1991.

A WOMAN OF THE SKIES: AN AUSTRALIAN'S CONTRIBUTION TO ATMOSPHERIC PHYSICS

Nessy Allen

D' Jean Laby, une physicienne australienne, est bien connue pour les recherches expérimentales de pointe qu'elle a conduites après la guerre. Grâce à ses études des rayons cosmiques, des vents stratosphériques et des aérosols, la plupart ayant recours à des sondages par ballon, elle a contribué à accroître les connaissances relatives à l'atmosphère, et plus particulièrement à l'hémisphère sud. À l'University of Melbourne pendant presque toute sa vie professionnelle, elle a participé à des enquêtes collectives avec l'US Atomic Energy Commission vers la fin des années 1960 et avec l'University of Wyoming dans le cadre du Climatic Impact Assessment Program (1972-1981). Ce document examine sa vie et son travail de physicienne atmosphérique solitaire au sein de la collectivité scientifique australienne de l'après-guerre.

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A WOMAN OF THE SKIES: AN AUSTRALIAN'S CONTRIBUTION TO ATMOSPHERIC PHYSICS

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ABSTRACT

Dr Jean Laby is an Australian physicist whose pioneer experimental research was carried out in the post-war period. In studies of cosmic rays, stratospheric winds and aerosols, most using balloon flights, she contributed to knowledge of the atmosphere, especially that of the southern hemisphere. On the staff of the University of Melbourne for most of her working life, she was involved in collaborative investigations with the US Atomic Energy Commission in the late 60s and with the University of Wyoming on the Climatic Impact Assessment Program 1972-81. The paper examines her life and work as virtually the lone woman atmospheric physicist in the Australian scientific community of the post-war period.

Although there have been women scientists in the past, very few of them have been physicists. Even today physics is considered to be the 'hardest' of all the sciences, both in the sense of being the most masculine and as the most difficult to master. Despite this, several women who were attracted to it have achieved prominence. This is certainly the case in Australia where, as far as I can discover, there were very few women physicists in the generation working during the immediate post-war period. This paper deals with the life and career of one of them, Dr Jean Laby. It is derived from a major study being carried out by the author of Australian women scientists who worked during and after the second world war, concentrating at present on those who have retired and who are available for interview.[1]

Jean Laby was born in Melbourne in 1915, the elder of two girls. That she became a physicist was almost inevitable, given her background. Her father, Professor T H Laby of

the University of Melbourne, was one of the best known and most highly respected physicists in Australia before the war. He studied in the Cavendish Laboratory at Cambridge where he met and became a friend of Lord Rutherford, the family sometimes staying with the Rutherfords when they were in England. Laby's influence on the growth of physics in Australia was very strong; at a time when undergraduate teaching was considered to be the main function of a university department, he 'established what was probably the strongest university research school in the southern hemisphere'.[2] He initiated radio research in Australia and was elected a Fellow of the Royal Society.

In some respects, then, Jean Laby can be said to have had enormous advantages: for the greater part of her childhood she lived in the grounds of Melbourne University and breathed in the ambience of scientific endeavour. One of her earliest memories is of her father on walks in the Melbourne Botanical Gardens teaching her about refraction by putting his walking stick in a pond and showing her how the stick appeared to bend. He saw to it that she went to an excellent school, one of the few girls' schools in Melbourne which taught science to matriculation level. On the staff were some first rate teachers, including one of his own MSc students.

It was of course expected that the child would study science; but she was in fact interested in it from a young age and it was her own wish to become a scientist. Though she majored in physics at the University (one of only a handful of women students) she did for a while toy with the idea of studying architecture. Therefore, at her father's suggestion, she enrolled in architectural drawing for one of her subjects. But she was the only girl in the class and was ignored by the lecturer to the extent that although there was a roll call at every lecture her name was never read out. She found the situation so uncomfortable that she withdrew from the course. She graduated in 1940, one year later than her contemporaries because her studies had been interrupted by a stay in England during one of her father's sabbaticals; during that year she attended some of Rutherford's lectures at the Royal Institution.

It is clear that her father's influence on her was strong but I think it was ambiguous in its effect. She disliked going to his lectures and being known as the daughter of a famous father. She did not take Honours ('I wasn't any good at exams'[3]) and it was only after her father's death in 1946 that she began to do research, graduating with an MSc in 1951 and taking her PhD in 1960, the first woman PhD in Physics at the University of Melbourne.

It seems that on completion of her first degree her father was not very willing to help her, telling her that she was now on her own. She therefore got herself a job with the Bureau of Meteorology in Melbourne – an organisation with which she would have a great deal of contact later in her career. But she never actually took up her appointment there. This was war time and as the young men in the universities joined the services, departmental heads found themselves short of staff. Professor Laby had to employ several women physics graduates as temporary demonstrators in the Department of Natural Philosophy and his daughter was one of these. Some stayed on after the war; 'they were not encouraged, however, to undertake advanced work, and all remained in junior positions in their department until close to retiring age'.[4] Laby was an exception in that she was appointed to a lectureship in 1958 and promoted to senior lecturer in 1961. She retired in 1980 after 41 years at the University.

During the war years, Professor Laby organised an Optical Munitions Panel for the development and manufacture of optical equipment for the three defence services. Laby, together with the other temporary demonstrators, worked on this project as part of her contribution towards the war effort. Just as she had disliked being a student in her father's department, so she disliked being a member of his staff, but now mainly because she could not help overhearing remarks about him made by students and other staff members who did not know the family connection. But this discomfort did not last long. Professor Laby was forced to retire in 1944 because of ill health.

Whether it was because she did not like teaching or whether it was because she no longer felt inhibited by the influence of her father, Laby now decided that she would like to become involved in research. In those days, a demonstrator had to apply for special

permission to undertake any research; having been granted it, she started work on the measurement of thermal conductivity, a research interest within the department, and submitted the completed project for her Master's degree.

Following this, she was invited by a member of staff, Dr V D Hopper, to join a group in the department working on cosmic rays with particular reference to high energy collisions. She had known Hopper, who was close to her in age, for many years as he had been one of her father's students and later his collaborator. In fact he had at times been a welcome addition to the family. Her father was reluctant to go on holiday unless he thought he would be able to do some work, but he could sometimes be persuaded if Hopper accompanied them.

It was in the course of this research that Laby began to work with balloons. Aircraft had already flown plates for cosmic ray investigations above 7.6 km. The group intended to send them higher on balloon flights, compare results at different altitudes and make a detailed examination of this method of studying high energy particles. By 1952 the group was achieving unprecedented results through the development of a valve mechanism which was activated when the balloon reached a pre-set diameter; they attained heights above 24 km for flights of more than 3 hours, and reached 38 km the following year. The Commonwealth Meteorological Bureau and the Department of Supply became interested in the project and provided help; they were soon using balloons fitted with the new valves.

1957-8 was International Geophysical Year. Because of this, the group, which had been publishing its results both in Australia and overseas, concentrated on intensive field work. At first it reported that 50% of their flights now reached altitudes exceeding 33.5 km and 30% over 36.5 km and 'a valuable set of information is being accumulated'.[5] Later their balloons reached an altitude of 40.8 km; cosmic ray plates were successfully recovered and were analysed for heavy primary interactions.

The importance of this work can be gauged by the fact that by 1956 the Nuffield Foundation had made two grants totalling 3,000 pounds. A further 5,000 pounds was

received in 1959 for the work to be continued in South Africa and South America. Laby went to South Africa for about 8 months during her sabbatical leave to work on this project; she wished to continue with it in South America but was prevented from doing so. The new Head of Department, whose disciplinary interests were in a different area, seems to have disapproved of the project. In addition, he was not favourably inclined either towards women or towards Laby; whichever was the case, she was forced to return to Australia.

Dr L H Martin, who had studied under and worked with Laby's father, had been invited to take up the Chair of Physics when the latter retired. He had been very active in defence work during the war and was mainly responsible for the establishment in 1961 of the Royal Australian Air Force Academy as an affiliated college of the University of Melbourne at Point Cook, some 30 kilometres from Melbourne. Hopper was appointed Professor of Physics and Dean of University Studies there and promptly invited Laby to join him. Until she retired she was the only female member of staff of the Department.

She continued her research at Point Cook on measurement of cosmic radiation, working also on projects to do with radar meteorology, balloon-borne cameras, and stabilised airborne repeaters. Though the work began at Laverton, Victoria, meteorological stations in both Queensland and New South Wales were used, necessitating considerable travel over wide areas of the country. Upper altitude wind investigations and stratospheric wind studies attracted the attention of the US Atomic Energy Commission which in 1966 awarded her a contract of $A100,000 over several years for stratospheric wind studies over Australia.

One of the objectives was to establish whether there was a transfer of air between the two hemispheres over the equator. It is of course easy to see the military implications of this kind of work. Much of it was done at the time when nuclear testing was being carried out above ground and information was needed on how far and in what directions radioactive material could travel. Laby herself, however, was never involved in any classified work; she was concerned only with supplying wind data.

In 1972 Laby became involved in the Climatic Impact Assessment Program of the US Department of Transportation funded by the US Office of Naval Research. Part of this global study relating to stratospheric aerosol particles was being undertaken by the University of Wyoming. The aim of the Australian section of the project was to supply southern hemisphere data for use in an assessment program of the effects of supersonic transport on the stratosphere. She carried out the experimental work, at first with a graduate student, and then on her own, sampling the atmosphere up to the lower stratosphere (about 30 km altitude): two sizes of aerosol particles, ozone, water vapour, temperature, pressure and winds were measured. Analysis of the data was made by Laby and the researchers at the University of Wyoming, involving her in a number of visits to that University.

In 1975 she was awarded a $US25,000 contract by the US Office of Naval Research in collaboration with the Division of Cloud Physics of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to measure southern hemisphere stratospheric aerosol. She continued this work until her retirement in 1980, studying particle sizes and their vertical distribution up to an altitude of 30 kilometres.

The kind of field work in which she was engaged during her career was physically very hard – it involved the handling of large and heavy gas cylinders, unwieldy balloons ranging from 3 to 6 metres in diameter on the ground and often fragile payloads. It also required long hours depending on the weather, and strenuous travelling, both to reach the weather stations and to follow the balloons by truck. Laby, who has a slightly built, delicate physique, was the only woman in all her projects. She now says that she felt people thought that 'it was sort of rather odd' – a woman not only doing physics but flying huge balloons.

Laby claims she never experienced any discrimination. But the listener to her story notices a number of instances which, although they may not be considered as outright discrimination, nevertheless give an indication of the stoicism of a woman who has had to deal many times with uncomfortable situations, from the time when as the only female student in a graphics design class her very presence was ignored. There were other

instances. The accommodation she was given at Point Cook was superior: she had a wardrobe with a special place for her sword! The all male classes often said 'Good morning, Sir' as she entered the lecture room; many times at meetings, attention was inadvertently focussed on her presence by the chairman saying, 'Lady and Gentlemen ...'; and she stopped going to 'Dining-In' nights when she found that the Matron of the Hospital also had to be invited. These are perhaps small things in themselves but to a sensitive woman they can become an ordeal.

It seems to me, moreover, that Laby was discriminated against in a specific way in that she was never promoted beyond the rank of senior lecturer. She published in world class journals, she worked with first rate physicists, she attracted large sums of money for research projects. According to Dr John Gras, now Principal Research Scientist in the Division of Atmospheric Research, CSIRO, she did 'world class work'.[6] Yet though she applied for a readership, she was not granted it and was not even given reasons for the refusal. Dr Gras, who was one of her PhD students, says that he felt she was always battling because she was a woman. He says that in those days 'women scientists were not really treated as equals – there was no level playing field'.

The documentation on the exclusion of women scientists from informal (usually male) networks is now considerable.[7] It is hard to know whether Laby was deliberately excluded from those operating at the University of Melbourne, but she was certainly not included. She tended to keep to herself but she did notice that there was definitely an 'in group' from which she was excluded. On the other hand, the position of staff recruited to the Point Cook Academy was somewhat difficult. Technically they were still members of the University and were expected to spend some time there. This meant commuting from one campus to the other, then a journey of some forty minutes. The working hours kept by the Academy and the University were quite incompatible making communication between the staff of the two places difficult and it is possible that this circumstance contributed to the feeling that she was not accepted by her male colleagues.

Laby's work situation became tenuous in another respect, although this had nothing to do with the fact that she was a woman. The Academy had not long been set up when rumours began to circulate that it was to be closed. Although this in fact only eventuated after Laby's retirement, the atmosphere at the Academy gradually deteriorated. Staff naturally began to look for other positions and the department was not permitted to appoint any new staff. A large research school had nevertheless been built up but it became more and more difficult to attract postgraduate students as no one could guarantee whether the Academy would still be operating for the term of their studies. Altogether the atmosphere was insecure and not conducive to sustained research. But Laby carried on with her work despite the uncertainties of the situation.

Although she was never ambitious, nor driven by the devil of egotism, she would have liked to have her worth acknowledged by being promoted. She has enjoyed her life though she is not entirely sure that she would pursue the same path if she had it to live all over again. Her greatest regret is that she was not a more effective lecturer. It was not the preparation of the material that she disliked. She never overcame her nervousness at facing a lecture hall full of students and much preferred teaching them their practical work. Best of all, she loved her research, particularly the later studies connected with the University of Wyoming. That her work with the research group there was appreciated is confirmed by the fact that she still has contact with those who were involved and with some of the CSIRO people with whom she collaborated. At least she has the satisfaction of knowing that there has been peer recognition of her work outside her institution if not so much within it.

Jean Laby is representative of those women scientists who worked during the post-war period without public acclaim. Many of the rapid technological advances set in motion by the exigencies of war demanded a greater knowledge of the environment for their successful implementation. Laby's results were not of the dramatic stuff that warrants headlines, yet the value of her contribution in atmospheric physics should surely be acknowledged. Tribute should also be paid to her as a woman who achieved distinction among her peers despite challenges to her confidence and self esteem. Far from having

her head in the clouds, she was prepared to rough it and to endure physical hardship with little reward in the quest for knowledge. She commands our respect.

FOOTNOTES

1. See Allen, N, 'Australian Women in Science - A Comparative Study of Two Physicists', Metascience, 1990, 8(2): 75-85; Allen, N, 'The Contributions of two Australian Women Scientists to its Wool Industry', Prometheus, 1991, 9(1): 81-92; Allen, N, 'Australian Women in Science: Two Unorthodox Careers', Women's Studies International Forum, 1992, 15(5/6): 551-562.

2. Caro, D E and Martin, R L, 'Leslie Harold Martin, 1900-1983', Historical Records of Australian Science, 1987, 7(1): 97.

3. From an interview with Jean Laby. Unless otherwise stated, all the statements made by Jean Laby are from interviews conducted by the author.

4. Home, R W, 'The Physical Sciences: String, Sealing Wax and Self-Sufficiency', in MacLeod, R (ed.), The Commonwealth of Science: ANZAAS and the Scientific Enterprise in Australia, 1988, Melbourne, OUP, 154.

5. Olver, N H (ed.), Report of Research and Investigation 1957, 1957, University of Melbourne, 267.

6. Stated by Dr John Gras, Principal Research Scientist in the Division of Atmospheric Research, CSIRO, in a personal communication to the author in October 1992.

7. See for example, White, M S, 'Psychological and Social Barriers to Women in Science', Science, 1970, 170(3956): 413-6; Cole, J R, 'Women in Science', American Scientist, 1981, 69(4): 385-91; Bruer, J T, 'Women in Science: Toward Equitable Participation', Science, Technology and Human Values, 1884, 9(3): 3-7; Astin, H S, 'Academic Scholarship and its Rewards', in Steinkamp, M W and Maehr, M L (eds.), Advances in Motivation and Achievement, 2, Women in Science, 1984,

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CAREER CHANGES WOMEN ENGINEERS: HOW ARE THEY DOING?

D' Mary R. Anderson

Aux États-Unis, de nombreux programmes d'intervention à l'intention des femmes dans le génie ont été mis sur pied à la fin des années 70 et au début des années 80. Le produit de ces programmes est au sein de la population active du génie depuis de nombreuses années maintenant. Comment vont ces femmes? Peu de recherches ont été conduites, avant le sondage intitulé «The Cooper Union 1989 National Survey of Women's Engineers», pour analyser le travail des femmes ingénieures sur une grande échelle. Ce sondage, auquel ont répondu 2 077 femmes (52 % des personnes à qui on l'avait adressé), comprenait quelques questions d'ordre démographique sur les femmes ingénieures qui travaillent, un profil de carrière, des questions d'égalité des sexes dans les milieux de travail (y compris la satisfaction au travail), un profil personnel et des questions relatives au mariage et à la famille.

Ce document a pour but d'analyser et d'évaluer la condition des femmes ingénieures diplômée du Graduate Career Change Program in Industrial Engineering de la Arizona State University. Mis sur pied en 1982, ce programme est l'un des rares programmes d'intervention au deuxième cycle universitaire toujours en existence. D'intérêt particulier est une comparaison entre les femmes en pleine transition de carrière et les femmes ingénieures employées interviewées par Cooper Union. En outre, afin de guider les futurs programmes d'intervention sur la bonne voie, on a interviewé les femmes en transition de carrière pour établir l'impact de leurs efforts en vue d'entrer dans le marché du travail. On leur a également demandé de fournir des suggestions pour la formation ultérieure des femmes ingénieures diplômées en transition de carrière. Les quelques hommes qui ont terminé le programme de transition de carrière à l'ASU ont également été interviewés et comparés à leurs homologues féminins.

Le document de recherche est disponible auprès de l'auteure.

CAREER CHANGE WOMEN ENGINEERS: HOW ARE THEY DOING?

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ABSTRACT

In the United States many intervention programs for women in engineering were started in the late 70's and early 80's. The products of those programs have now been in the engineering work force for several years. How are these women doing? Little research had been conducted to evaluate the working woman engineer on any large scale until "The Cooper Union 1989 National Survey of Women Engineers" was completed. This survey, with 2077 respondents (a 52% survey return), included the demographics of the working woman engineer, a career profile, gender issues in the work place (including job satisfaction), a personal profile, and marriage and family issues.

The focus of this paper is to similarly survey and to evaluate the status of the women engineers who have graduated from the Arizona State University Graduate Career Change Program in Industrial Engineering. Established in 1982, this program is one of the few graduate level intervention programs with a history of several years and that is still in existence. Of particular interest is a comparison of these career change women engineers with the working women engineers surveyed by Cooper Union. In addition, to help give good direction for future intervention programs, the career change women have been surveyed for an evaluation of the strengths and weaknesses of their preparation for the workplace. They have also been asked to give suggestions for the future training of graduate career change women engineers. The few men who have completed the career change program at ASU have also been surveyed and compared to their female counterparts.

Contributions - GASAT 7 International Conference, Canada, 1993
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WOMEN TOWN PLANNERS: STAYING IN THE COURSE

Clara H. Greed

Ce document est basé sur des recherches actuellement en cours sur les femmes urbanistes en Angleterre. On a recours à une approche ethnographique à grande échelle, ainsi qu'à des sondages envoyés par la poste aux collèges et employeuses et employeurs, visant à nous permettre de réunir de l'information de sources variées sur la situation des femmes et les politiques d'égalité des chances. Quinze pour cent seulement des urbanistes qualifiés, mais près de 40 % de l'effectif des programmes d'urbanisme sont des femmes. On a découvert que, en dépit des politiques «d'égalité des chances» instituées dans les collèges, la position qualitative des étudiantes ne correspond pas forcément à l'augmentation des nombres. Les femmes occupent plus souvent des postes de service que les hommes dans l'exercice professionnel, quels que soient leur âge et leurs qualifications. On en conclut que les critères sur lesquels se basent les politiques d'équité doivent être réexaminés, de façon à éviter tout parti pris contre l'autre sexe. Les politiques axées sur les femmes doivent être considérées en tant que composante structurale intégrale d'un organisme et non pas en tant qu'ajout ou sujet marginal qui ne concerne que les femmes.

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WOMEN TOWN PLANNERS: STAYING THE COURSE

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ABSTRACT

This paper is based on research currently being undertaken on the position of women town planners in Britain. A broadly ethnographic approach is being used combined with postal enquiries to colleges and employer bodies to elicit information on women's position and equal opportunities policies. Only 15% of fully qualified planners, but nearly 40% of planning students are women. It is found that, in spite of 'equal opportunities' policy statements in colleges, the qualitative position for women as students is not necessarily commensurate to the increase in their numbers. Also women are generally in more junior positions than men out in professional practice, irrespective of age and level of qualifications. It is concluded that the criteria upon which the operation of equality policies are based require re-examination, to avoid gender bias. Women-related policy needs to be seen as an integral, structural component of an organisation's remit and not as a separate add-on, marginal topic: only of relevance to women themselves.

INTRODUCTION

Town planning is one of the built environment professions, which like surveying, architecture and civil engineering, has a low representation of women: 15% of full members of the RTPI (Royal Town Planning Institute) are women. Town planning is a classic example of a composite profession, which grew out of these older professions, to provide state intervention

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over the built environment through the statutory local government development control system. The very existence of both town planning courses and the modern profession itself is dependent upon this link (Rodriguez-Bachiller, 1988). Therefore it may also be seen as an area of 'social policy' which, arguably, makes it appear 'softer' and more welcoming to women than the 'harder' commercial and technologically orientated construction professions. But many women are of the opinion that contending with the 'local government bureaucratic fraternity' can be more daunting than taking one's chance in private sector professional employment. Higher education itself has expanded greatly in Britain, in recent years, although still nowhere to the same degree as is the case in the USA. Town planning courses have experienced considerable increase in student numbers in recent years, partly because of growing interest in environmental issues, and undoubtedly, planning is seen by some women and men as, relatively speaking, an easier route into the professional classes compared with taking more elite courses such as architecture. However, as more women enter, it is noticable that separate specialisms seem to be emerging which are reserved for women. Also, it may be argued that the status of the whole profession has dropped, precisely <u>because</u>, more women are entering (compare, Reed, 1991). Also 'layering' can be observed vertically within planning organisations, significantly with women being marginalised into the less senior positions, and into short term and part-time work, regardless of their qualification level.

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In my current research on women town planners (Greed, 1992; and forthcoming), I am finding that the situation is remarkably similar to that in the surveying profession which I previously investigated (Greed, 1991) although the planners are meant to be 'the good guys', who care about society, compared with their more commercial surveying brethren. Again I was to find that the issue of whether women had different views and policy priorities, was secondary, since few women were likely to reach decision making positions because of the nature of the professional subculture and related occupational and organisational structures, even though there is a higher percentage of women in planning than surveying. Unlike surveying there has always been a slightly greater number of women in the RTPI, and in voluntary organisations concerned with urban problems, but they appear to have known their 'place' or have been kept 'down' by a range of marginalising tactics. Numerically the Royal Town Planning Institute is a small professional body containing under 17,000 members. Planners are operating within the context of the construction industry, in which over 2 million people are involved and over 95% of these are male (CISC, 1992). Whilst women make up over 18% of town planners (all categories), the number of women is much lower in other key professions, such as civil engineering, architecture and surveying. Although only 7% of surveyors but 18% of planners are women, there are only half the number of women planners as there are women surveyors (around 3000 as against 6000) because there are over 86,000 surveyors. (A similar 'amazing fact' is that in the United States in 1982, 50,000

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women held PhD's in science and engineering as against 20,000 in humanities. Women constitute a quarter of humanities doctoral students as against 12% of science but the latter field is so much larger, Kirkup and Keller, 1992: 30)

LEVELS OF SENIORITY

Less than 5% of senior planning officers are women, and there are vast areas of policy which have hardly been touched by a gender perspective, and many offices where most of the staff are men and no-one takes much interest in women's issues, especially in the provinces, and rural areas (RTPI, 1989, : 47). According to Nadin and Jones (1990) three quarters of women members are under 40 whereas men are fairly evenly spread over the age groups with less than a half of men being under 40. Between the ages of 25-34 women make up a third of all members, but between the ages of 40-50 they make up 1 in 10, and from 50 only one in 20 of the membership, but even so, women are disproportionately under-represented, as in surveying, in the higher echelons. There appears to be little correlation for women between educational achievement and progression, although women planners appear to be better qualified than the men. However women who have taken planning at post graduate level are more likely to be found in policy making areas rather than in statutory development control.

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Women's progress is particularly marked in London borough planning authorities where around 20% of all women planners are working, and where there are a few women chief officers (Nadin and Jones, 1990). In the shire county councils and rural districts there is quite an irregular distribution of women, so that it is difficult to generalise. However in one authority it was found that 40% of women were on the lowest scale but no men were, and 50% of men were on the highest scale but no women. One is less likely to find such a disparity in metropolitan areas, as there is a greater distribution of women along the staircase up to middle management levels and in some of the 'good' authorities, around 12-15% of women will be found at PO (principal officer) grade. Progress is not guaranteed, as with surveyors, there is a log jam developing at the lower management level as more women work their way up only to encounter a glass ceiling. Some women find, after taking a career break, that they return to a lower grade than before they left. In some local authorities where progress had previously been made major reorganisation of local government managerial structures has occurred creating new male, cross departmental, oligarchies which marginalise women who had previously held senior positions in planning, housing, social services and education.

AREAS OF SPECIALISATION

As in surveying, women planners are generally concentrated in certain specialisms, but to a less marked degree, with individual women found in

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just about every area: albeit often on a low grade. Men too are spread across a wide range of specialist areas, and although the general public often imagines all planners work in development control (statutory procedure for control of new development) less than a third do so (Nadin and Jones, 1990). Women appear to be more noticably concentrated in development control, social aspects of local planning, and to some extent, countryside planning. In contrast certain areas are strongly male, such as transportation planning, strategic developmental and forward planning, anything to do with sport, and areas of planning related to commercial property investment and industry, especially when planning is undertaken in partnership with the private sector. However, I have found individual, maverick women working in totally male teams, in transportation, and in minerals (a very male area and a county planning function), where against the flow, they have carved out a niche for themselves. Some such women, although on middle level grades may be the only holders of specialist information in their department, so men show them respect for fear of being cut off from vital data. The woman planner as statistician is a gender-defying variation, but, it would seem one of the most successful 'types' of woman planner in terms of promotion, although numerically rare. Apart from such 'exceptional women', three roles were common for women (as also found in the case of surveying, Greed, 1991):- firstly that of being a 'helper'; secondly being involved in social and housing issues - such as dealing with 'minority' issues including 'women and planning' - rather than having a

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managerial, design or developmental role; and thirdly, anything to do with 'prettifying', which could vary from the woman being given a public relations role, to being involved in landscaping or townscape control.

ATTITUDES AND EQUAL OPPORTUNITES

In all areas of planning the majority of planners are men, and on a daily basis, many women planners still encounter incidences of thoughtless sexism, and discrimination, although, curiously, many men appear to believe the problem has now been solved. This is evidenced by the fact that I got a very low response rate to my enquiries, both quantitative and qualitative, as to the position of women in planning. I wrote to all town planning courses seeking information on the numbers of women students and also inviting general comment, and to all the RTPI regional branches and a range of local planning authorities. When I 'did' the surveyors using the same methodology and wording to my enquiries, in the late 1980's I had a 60% response. In contrast I received around a 15% response from the planners. On the grapevine I got the impression that no-one was particularly interested because they had already 'done' women, and had now moved on to green issues or inner city problems. Perhaps, women's place in planning was never intended to be great: from the beginning they were seen as a reserve labour force, rather than as leaders and seers.

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Whilst everyone 'pretends' women and planning is an important issue, interest and resources have fluctuated. During the relative heyday of the 1980's many local authorities appointed Equal Opportunity officers, and one would often find a woman, usually one woman note, appointed as 'women's co-ordinator' or 'planning equal opportunities officer' to 'advise and monitor policy' in various planning authorities. Such responsibilities put considerable strain on the incumbents of these posts. Women planners have observed that such initiatives have been 'offered without timescale, budgets, or priorities' and have been labelled as, 'simplistic, inadequate, and tokenistic' (WEB, 1990). In conclusion, although the situation might appear 'better' nowadays because more women are entering planning courses, the employment situation which awaits them is not encouraging. Also, the prospect of employment seems to become more distant. As higher education in Britain moves further towards the 'american' two-tier model of post-graduate professional qualification, routes to becoming a planner become longer, with more hoops to jump through, and women find it difficult to last out the course, as college education clashes with their 'other' role and related financial commitments. To achieve 'equality', fundamental changes in planning education and practice are required: rather than just 'letting' increased numbers of women come in, and expecting them to fit in to existing male organisational structures. The gendered nature of the criteria which are used to judge if someone is the 'right type' need to be changed to let more women through, and alter the professional culture.

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THE BRAIN DRAIN PHENOMENON: A CASE STUDY IN THE COLLEGE OF HEALTH SCIENCES, UNIVERSITY OF BENIN, NIGERIA

D' Ahbor Dolly A. Ighoroje

Une définition très libérale de l'exode des cerveaux, tel que le considère le Federal Republic of Nigeria Presidential Committee on Brain Drain (1989), dans le contexte de la situation du Nigéria est la suivante : «L'abandon par des femmes et des hommes professionnels hautement qualifiés, des intellectuelles et intellectuels, des talents et des spécialistes de n'importe quel domaine d'activité d'un contexte social spécifique - que ce soit un pays, un organisme ou une profession - dû à une rémunération médiocre ou inadéquate ou au fait qu'elles ou ils ne peuvent poursuivre leurs objectifs professionnels dans le contexte social donné». Cette définition explique bien le phénomène général d'exode des cerveaux auquel nous nous heurtons au Nigéria, en particulier au College of Health Sciences. Elle risque pourtant de ne pas s'appliquer aux cas de migration des travailleuses scientifiques, et plus particulièrement au Nigéria, où les mariages et les responsabilités familiales dictent généralement le choix et les conditions de carrière de la travailleuse scientifique.

Ce document tente tout d'abord d'expliquer la tendance générale en matière de migration des enseignantes et enseignants et des spécialistes au College of Health Sciences de l'University of Benin au cours des dix dernières années et analyse ensuite dans quelle mesure les femmes s'abandonnent à cette tendance. Nous tenterons également d'expliquer les raisons de la tendance suivante : les femmes changent moins souvent de carrière mais interrompent plus souvent leur carrière.

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THE BRAIN DRAIN PHENOMENON: A CASE STUDY OF THE TREND IN THE COLLEGE OF HEALTH SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA; HOW INVOLVED ARE THE FEMALE SCIENTISTS?

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ABSTRACT

A very liberal definition of brain drain as defined by a Federal Republic of Nigeria Presidential Committee on Brain Drain (1989) in the context of the Nigerian situation is "The departure of highly trained professionals, intellectuals, talents and specialists in any field of endeavour from a specific social context - be it a country, an organization, or an occupation - as a result of frustration from poor or inadequate remuneration, or from not having opportunities to fulfill professional aspirations in the given social context". This definition aptly covers the basic reasons for the general trend in brain drain obtained in Nigeria as a whole and in particular the College of Health Sciences in recent years, as a result of the burdens of the Structural Adjustment Programme (SAP) adopted to revamp the ailing economy. The above reasons however may not always apply in cases of migration of female scientists, especially in Nigeria as marriage and family commitments generally dictate the career moves and terms of the female scientists, because of the cultural and societal importance of marriage to the average Nigerian female.

This paper intends to first show the general trend in the migration pattern of medical and paramedical teachers and specialists in the College of Health Sciences, University of Benin, Nigeria in the past 10 years and secondly to analyse how involved the female counterparts have been in the trend. It also intends to elucidate reasons for the trend observed - viz: females are less active in migration but are more prone to career interruptions.

INTRODUCTION

The phenomenon of brain drain is a common one all over the world because it entails the movement of highly trained specialists or professionals from one region to another region due to a variety of reasons but mostly due to a need for

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greener pastures. In Nigeria the story has been the same especially since the introduction of a Structural Adjustment Programme (SAP) in 1986 by the Federal Government in order to revamp the ailing economy. Brain drain as it relates to the university involves the movement of the specialists into the more bouyant private sector within the country or movement out of the country to other parts of the world. It has several causes, most important of which are (a) lack of university funding resulting in lack of facilities at work place and (b) poor personal emoluments leading to lack of interest and low input at workplace - all these resulting from the generally bad economic climate of the Nation.

The general trend nationally for women's participation in brain drain is quite low when compared to their male counterparts. This is due to a variety of social and traditional reasons the most common being the importance attached to marriage and motherhood in our African setting. Most professional women are usually therefore tied down to the strings of their husbands' apron's no matter how highly skilled or trained they are and will prefer to go along with whatever decisions the husbands take. In most cases the husbands will not agree to follow their wives anywhere, the traditional African society being a chauvaunistic one where the woman should do what she is told and should always be subjected to the man. A professional woman would therefore not necessarily seek to migrate to greener pastures or even if she was bold enough to seek and obtain a job she would would not likely take it up if the husband himself has not obtained one, for he is not expected to stay back and look after the children or most importantly he is not expected to follow his wife to her new job.

This study was undertaken in order to investigate the

migration patterns amongst males and females and to elucidate seasons for the observed pattern in the College of Health Sciences, University of Benin. Senior female nurses at the University of Benin Teaching Hospital were also included in the assessments because of the relatively low number of the females in the College.

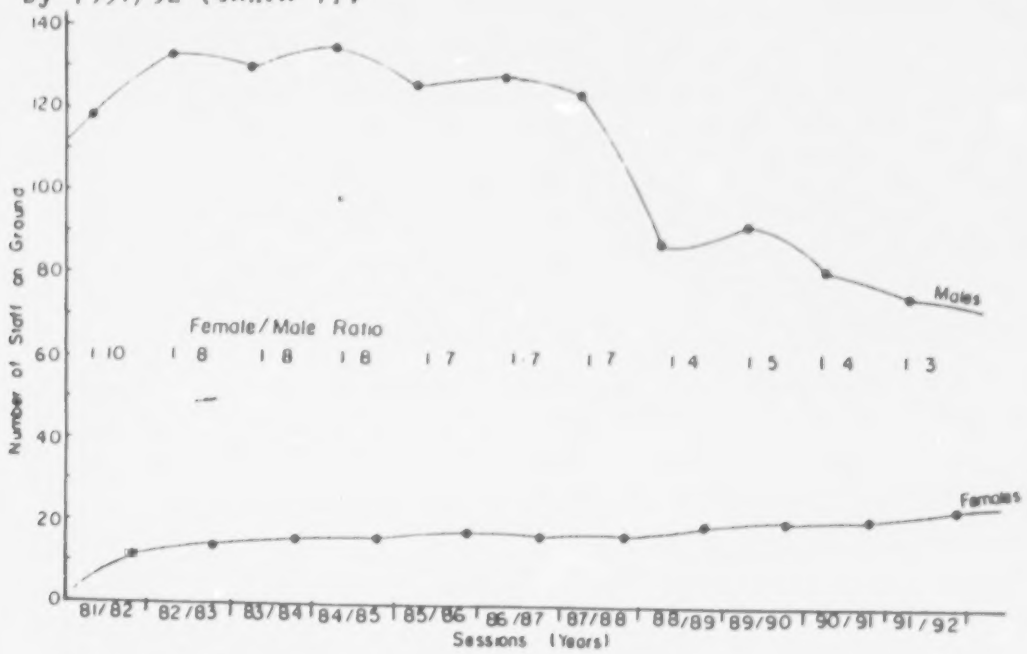
METHODOLOGY

The study had two components, the first being collation of the number of both female and male members of teaching staff of all three faculties which comprise the college viz: the Faculties of Medicine, Pharmacy and Dentistry over the past ten years starting from 1981/82 academic sessions through to the 1991/92 academic sessions. The data for this was obtained from the University of Benin Academic Planning Division. Graphs of the total number of professional in all the three departments for males and for females over the 10 year-period between 1981/82 session to 1991/92 session were plotted.

The second component of the study design consisted of a survey. Because of the need for a larger survey population for better assessments of reasons for migration, in addition to the regular staff of the College, some resident doctors and senior female nurses at the University Teaching Hospital who are also involved in the teaching and training of the same sets of medical students were included in the survey. 150 questionnaires were administered. The questionnaire was all embracing and included questions that were designed to elicit relevant answers to the reasons for migration, or non-migration. Other information required included the age, marital status, and the family status i.e. number and ages of children. Some were orally interviewed.

RESULTS

Over the 10 year-period spanned, the number of female staff increased rather than decreased showing the lack of female migration. On the contrary there was a drastic reduction in the number of male staff starting from the 1987/88 sessions this period corresponding to the down turn of the nations economy and the beginning of the Structural Adjustment Programme (SAP). The female-male ratio in the College steadily increased from about 1:10 in 1981/82 to 1:3 by 1991/92 (GRAPH 1).



Graph 1 Showing the number of male and female professionals in all the departments of the three faculties (Medicine, Dentistry and Pharmacy) which make up The College of Health Sciences over a 10 year period from 1981/82 session to 1991/92 session

The total response rate to the questionnaires administered was 59% females contributing 36% and males 23%. There was no significant difference in the family or social status of both females and male professionals.

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TABLE 1

Responses of Male and Female Professionals to the idea of Migration

		% of Respondents	
		Males	Females
If offered jobs outside the country will you accept for a period?	YES:	88	67
	NO:	12	19
	Conditional	0	14
If Yes due to:	(1) Purely financial reasons	24	39
	(2) The need to travel out of Nigeria.	10	10
	(3) The need to work under more acceptable working conditions.	59	51
	(4) Others (specify)	7	0
If No due to:	(1) Family commitments.	80	58
	(2) Better conditions of services in Nigeria.	0	14
	(3) Other social commitments.	20	14
	(4) Other reasons (specify)	0	14
If your spouse is offered such a job will you easily go along even if you have no job offer?	YES:	24	35
	NO:	59	37
	It depends/No response	17	28
Would you want to emigrate to another country?	YES:	24	22
	NO:	71	59
	No response	5	19

DISCUSSION

The findings of this research showed that females hardly participated in migration even in very adverse situations, irrespective of their level of qualifications, the status of their families and how they feel like. Some may actually want

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to emigrate but cannot simply because of societal expectations. They are often weighted down by commitments to their families especially the nuclear and often the extended. Their decisions are vetoed by their husbands who in typical African settings cannot allow their wives to decide where the family should move to or not. Wives are expected to move easily with their husbands as long as it is the husband who has taken the decision to move. Even single females would not move even if given better prospects and opportunities because they would rather stay around and pick suitable suitors first. The very high percentage of females (67%) who responded that they would like to take up jobs from abroad temporarily if offered showed that females are quite willing to move. The questions however is do they actually move? They do not!! There was an increase in the female-male ratio from about 1:10 in 1981/82 to 1:3 in 1991/92 (Fig.1) showing that while their male counterparts left for "greener pastures" their positions were taken up by the females, some of whose husbands were even temporarily working outside the country. During oral interviews, most females indicated that even though they would not mind taking up more lucreative jobs outside the country they are weighed down by other family and social commitments and would rather stay back to please others, other than themselves. They would rather their husbands do the moving around since he is the boss and therefore turn down better and more lucreative offers that would have otherwise been good career moves. They tend to show and also experience a fear of success because they do not want to be seen to be competing with their husbands. Hones and Walsch (1974), Ezielo (1992) had found that women tend to experience a fear of success because of prevailing social order and acquired values. The

same females have more career interruptions especially the young married and unmarried ones who would stop work temporarily to rear children or move to wherever their spouses are to get married or don't make a better career move just so as to pick a husband first. Some females even deliberately give up in striving to excel in their careers and therefore stagnate in their careers and will not even make efforts to move to better places primarily because they are not expected to be better than their spouses/husbands or to be seen to be dragging their husbands along.

Most of the female respondents who indicated willingness to take up a job abroad temporarily appreciated the need to work under more acceptable/suitable working conditions, the need for better financial status, and the need to enhance productivity in order to get better psychological satisfaction on the jobs just like their male counterparts did. The others who did not show willingness even to take up a job temporarily outside the country or elsewhere would not do so because of their commitments to their families and societies. Some were satisfied with their financial status because they were financially supported adequately by their husbands and are therefore more comfortable here at home.

On the questions of following their spouses abroad irrespectively of their own job status expectedly more males (54%) indicated that they would not follow their wives as against 24% who were willing to follow their wives. On the contrary slightly more females (37%) indicated they would not like to follow their husbands as against expectations. 36% said they would follow while 28% either did not respond to the question at all or indicated that their actions would be conditional on a number of reasons. A lot more females are

are thus showing more independent attitudes than were obtained previously when all females would have readily said they would follow their husbands. Both female and male respondents who are willing to follow their spouses recognise the need for the family unit to remain together, the need for stronger emotional bonding in addition to the need for better financial and social welfare. Only females recognise the welfare of the children as a primary concern. This may be because of the relatively dormant participation by the males in the upbringing of the children in traditional African settings that expect fathers to only provide money while the mothers are expected to bring up the children properly.

Unexpectedly, some of the reasons given by male respondents for declining to follow spouses such as "staying back to look after the children but allowing wife to go in order not to interrupt her career are atypical of general African attitudes. Reasons more typical to these attitudes, are "It is never done in this part of the world for a husband to follow his wife" "I am the head of this family and all decisions rest on me" and "the wife should stay back to look after the children".

A majority of females (59%) and even males (71%) would not like to emigrate totally because there was no place like home and they would rather be patriotic and stay at home to contribute their quota to National development. Some felt they were rather too old to emigrate others were simply contended and were doubtful as to their acceptability in host country where they fear being classified as second class citizen or were they may have cultural shock.

Although the professional, economic and family status of both female and male professionals are not significantly

different from one another in the College of Health Sciences University of Benin, Nigeria, the females are more docile in terms of migration. A lot of factors account for this trend, the most important of which are the commitment to the family and fulfilment of societal expectations and obligations. Currently females are however adopting more liberal and independent attitudes whether they can actually practicalise these attitudes in future remains to be seen.

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GENDER, POSITION, AND COMPUTERS IN THE WORKPLACE

Hilary M. Lips, Jerri L. Frantzve, Christina Wynings, Richard Castor, Brian Pack, and Karen Wilson

Le sexe, la prise de conscience des ordinateurs et le contexte social dans lequel ils sont utilisés de nos jours ont tous été reconnus comme des facteurs d'influence dans le développement des attitudes à l'égard des ordinateurs. Pour examiner plus à fond la relation entre ces différents facteurs, un questionnaire sur les attitudes à l'égard de l'informatique a été conçu et administré à 157 employées et employés de plusieurs organismes de services. Les répondantes et répondants ont également rempli un deuxième questionnaire incluant des questions sur leur rôle et leur niveau au sein de l'organisme, leur expérience informatique, l'utilité de l'ordinateur dans le cadre de leur travail et les tâches spécifiques où elles et ils utilisent l'ordinateur.

L'analyse factorielle des réponses au questionnaire sur les attitudes a permis de reconnaître six aspects des attitudes face à l'ordinateur, dont trois démontrant un lien entre l'informatique et le pouvoir perçu : compétence/pouvoir interpersonnel, contrôle/exécution et efficacité professionnelle. L'analyse des relations entre les résultats des individus relativement à ces trois facteurs, et leurs réponses au deuxième questionnaire, ont indiqué que le niveau organisationnel, le type d'organisme et la nécessité d'utiliser un ordinateur représentaient de meilleurs indicateurs des attitudes face à l'ordinateur que le sexe ou l'expérience en informatique. Les résultats, démontrent que c'est le milieu de travail, et non pas le sexe, qui constitue la principale considération dans les attitudes face à l'ordinateur. Ces résultats sont examinés dans le but de rendre ce contexte plus positif pour les femmes.

GENDER, POSITION, AND COMPUTERS IN THE WORKPLACE

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ABSTRACT

Gender, exposure to computers, and the social context in which computers are used have all been identified as influences in the development of attitudes toward computers. In order to explore these relationships, a 59-item scale emphasizing power-related aspects of attitudes toward computing was developed and administered to 157 female and male employees of several service organizations. These respondents also completed a second questionnaire which included questions about their organization level and role, computer experience, necessity of computer use for their job, and specific tasks for which they used the computer.

Factor analysis of the responses to the attitude scale identified six aspect of computer attitudes, three of which appeared to be reflective of a link between computing and perceived power: Competence/Interpersonal Power, Control/Lack of Frustration, and Work Efficiency. Analyses of the relationships between individuals' scores on these three factors and their responses to the second questionnaire indicated that organizational level, type of organization, and the necessity of computer use on the job were better predictors of computer-related attitudes that were gender or gross measures of computer experience. The results, which indicate that workplace context, not gender, is the crucial consideration in computer-related attitudes, are discussed in terms of how that context can be made a more positive one for women.

INTRODUCTION

The image of computers and computing as forbiddingly complex, and the mystification of the skills and processes related to computing can have an intimidating effect on the

uninitiated. Computing, like mathematics, is sometimes deemed to require special talents, possessed by only a lucky few. This elite image of computing is often fostered, knowingly or unknowingly, by institutional computer services departments which dole out information to users in a miserly fashion and make frequent and arbitrary changes to the system so that users never feel quite comfortable with their skills.

The careful control of system-related information serves the interests of computing "experts" in a very real way: it safeguards an important source of their power. When we began to study computer-related attitudes, our interviews with and observations of computer users in university settings made it clear to us that the power--powerlessness dimension was an important aspect of these attitudes (Lips, Foster, Frantzve, Kraus, & Castor, 1991). Power was an issue for computer users in two ways: computer expertise was a source of power and influence, and people in powerful positions had more flexibility in acquiring -- and in defining -- such expertise.

Research demonstrates that social/environmental context is a critical factor in understanding computer use and attitudes (Kramer & Lehman, 1990). The power to limit knowledge or to define what skills or approaches to computing are appropriate helps to shape that environment, keeping some people away from

computing by intimidating them or simply by making them feel reluctant to join in (Turkle & Papert, 1990). Thus, we focused our investigation on the relationship between computing and power.

To explore these issues further, we developed an attitude scale to assess perceptions of the relationship between computer use, expertise, and feelings of power.

METHOD

We developed a series of statements that emphasized several power-related aspects of computing: interpersonal influence associated with computer expertise, feelings of frustration and lack of control linked to computing, feelings of expanded work capacity and efficiency, beliefs that computers were "taking over" society. After pilot-testing these items for clarity, using a small sample of evening-school adult students, we selected 59 items for the attitude scale. A second questionnaire, which included items about demographics, organizational level and role, computer experience, necessity of computer use on the job, and tasks for which the computer was used, was also devised.

Both scales were administered, in the workplace, to 157 female and male employees of several service organizations: an insurance company, a hospital, a university, a marketing

agency.

RESULTS

The respondents included 99 females and 58 males. They ranged in age from 21 to 61, with a more than 40% falling between the ages of 30 and 40. Their years in the work force ranged from less than 5 to 42, with 22% having less than 5 years of work experience, 9% having more than 25 years of work experience, and the largest group (29%) having between 16 and 25 years on the job. Their educational level ranged from high school to doctoral degrees, with the largest percentage (36%) holding an undergraduate college degree.

Responses to the attitude scale were subjected to principal components analysis with varimax rotation. A scree test indicated that the optimum number of factors for extraction was 6. When the analysis was limited to 6 factors, these factors accounted for 51% of the variance.

Three of the extracted factors were interpreted as relevant to the anticipated link between computing and perceived power. The first, labeled Competence/Interpersonal Power, showed high loadings on items such as "My coworkers come to me for help when working on a computer problem," "I feel important when others have to ask me for computer information" and "My computer expertise gives me influence over some of my

co-workers." The second, labeled Control/Lack of Frustration, included high negative loadings on items such as "I do not feel I have control over what I do when I use a computer," "Work has become less flexible and more rigid since computers were introduced," and "Working on the computer always makes me tense and uncomfortable." The third, called simply Work Efficiency, was composed of high loadings on such items as "The efficient use of computers saves money, time, and space," "Computers increase freedom to explore new possibilities," and "Using a computer to do work saves me a lot of time." The remaining 3 factors were Acceptance of Computers (eg. "Computers are interesting"), Positive Social Identity (eg. "I gain prestige from my ability to use computers") and Power of Computers in Society (eg. "Computers eliminate jobs").

Factor scores were calculated for each individual on each of the factors. A series of analyses of variance comparing females and males on each of the six factor scores revealed no significant gender differences on any of the factors.

When occupational grouping variables were examined, significant group differences were found on some factors. The individual's organizational level/role was related significantly to scores on all three power-related factors. Organizational level was significantly related to

Competence/Interpersonal Power, F (4,153)=7.21, p<.0001, with members of technical occupations scoring highest, clerical staff scoring much lower, and upper and middle management scoring in between. A similar pattern was noted in the relationship between organizational level and Work Efficiency, F (4, 153)=4.51, p<.002., and for the association between organizational level and Control/Lack of Frustration, F (4, 153)=2.85, p<.03. Occupational level/role was, in some respects, confounded with gender: females made up 79% of the respondents in the clerical level; the technical level was 56% male; 61% of the respondents in the both the middle and upper management groups were female.

Necessity of computer use on the job was significantly related to respondents' scores on Control/Lack of Frustration, F (4, 153)=11.5, p<.0001, with the greatest sense of control reported by those who described computer use as either a definite job requirement or looked upon favorably by superiors, and the lowest scores reported by those who said they were either free to use or not to use computers or were under great pressure to use computers. Necessity of computer use on the job was also significantly related to scores on Work Efficiency, with workers who described themselves as under great pressure to use the computer scoring lower than other

groups.

DISCUSSION

Since no gender differences in computer-related attitudes were found, these results may appear, at first glance, to have little relevance to concerns about gender and technology. Yet they are doubly relevant. On the one hand, they help to undercut the stereotype that women and computers don't mix. Female and male managers, for example, obviously differ little from each other in the ways they associate computing with power. If women and men are really in comparable occupational positions, gender differences in attitudes are not apparent. This finding is reminiscent of Rosabeth Kanter's (1977) wellknown finding that gender differences in managerial behavior disappeared when she controlled for the type of position held.

On the other hand, the demonstration of an association between organizational level/role and power-related computer attitudes highlights one of the major difficulties faced by women in the typical workplace characterized by occupational gender segregation. Women and men tend <u>not</u> to be in comparable positions. Women are most likely to be clustered in clerical positions. Technical positions are more likely to be held by men.

In our sample, which was 63% female, the only occupational level/role in which men formed a majority was the technical one. More than three-fourths of the clerical group, on the other hand, was female. The technical group, more than any other group, associated computing with feelings of power: interpersonal influence, feelings of control, and the sense of expanded capacity. The clerical group, on the other hand, scored lower than any other group on all three dimensions.

Although secretaries and other clerical workers now must have certain computer skills, working conditions for clerical staff are not conducive to learning more about computing than absolutely necessary. There is little possibility that a secretary, no matter how competent she becomes at various aspects of computing, will be able to move up into the ranks of the technical staff. Nor is there much chance that her expertise will be appropriately recognized and financially rewarded. These are aspects of the workplace that could be changed -- while waiting for the efforts to break down occupational gender segregation to bear fruit.

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THE FLEDGLING PROJECT: MUTUAL SUPPORT STRATEGIES FOR WOMEN IN EMPLOYMENT

Gillian Smith and Ann Walton

À cette étude préliminaire participent un groupe de femmes qui sont, ou ont déjà été, employées à l'extérieur de leur domicile pendant de longues périodes. Leur expérience collective s'étend sur les cinquante dernières années; une période qui a vu d'importants changements dans la prise de conscience et les lois relatives à l'égalité des chances. Le projet examine dans quelle mesure les progrès de ces femmes sont attribuables à des facteurs quelque peu moins apparents, tels que leurs propres qualités et attitudes, ainsi que le comportement des autres gens à leur égard.

Un système structuré a été mis en place pour leur permettre de s'aider les unes les autres à repenser leurs expériences et à en tirer des principes et modèles qui pourraient former un ensemble cohérent de directives qui ont fait leurs preuves. En accordant de la valeur au savoir des femmes et en le leur faisant savoir, on espère les inciter à développer des opinions conscientes de leur rôle par rapport aux autres femmes au sein de la population active. Il existe une hypothèse sous-jacente comme quoi, bien que cela soit particulièrement important pour les personnes qui occupent des postes de gestion, toutes les femmes, quel que soit leur niveau, ont l'occasion de jouer ce que l'on considère comme un rôle essentiellement d'encadrement ou «parental». Le thème principal de ce projet, soit le travail en couples est, à notre avis, tant une façon agréable pour tout le monde de recueillir des renseignements qu'un modèle de l'approche mutuellement coopérative et non hiérarchique que l'on peut considérer comme caractéristique des femmes.

L'intérêt sied dans les suppositions que (a) les femmes ont une énorme réserve de connaissances «cachées», (b) la méthode les aide à «déballer» ces connaissances dans un contexte de groupe de semblables, (c) la réflexion est une façon de développer sa propre pratique et (d) l'application de la théorie d'apprentissage est appropriée.

Les influences qui émergent de cette étude sont illustrées par rapport aux membres du groupe-échantillon dans les professions scientifiques ou connexes.

THE FLEDGLING PROJECT: MUTUAL SUPPORT STRATEGIES FOR WOMEN IN EMPLOYMENT.

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ABSTRACT.

This preliminary investigation involves a group of women who are, or have been, employed outside the home for substantial periods. Their collective experience spans the last 50 years; a period which has seen major changes in equal opportunities awareness and legislation. The project sets out to explore the extent to which their progress has also been assisted by other less high profile factors such as qualities and attitudes in themselves and the behaviour towards them of other people.

A structured system has been developed to enable them to help each other to reflect on their experience in order to draw from it principles and patterns to be brought together in a set of tried and tested guidelines. By giving value to what women know and by making it explicit, it is hoped that they may be encouraged to build their insights in a conscious way into their practice in relation to other women in employment. There is an underlying assumption that, while this is particularly important for those in a management position, all women at any level have opportunities to take on what is essentially a mentoring or nurturing role. The emphasis on working in pairs in the project is, we feel, both a woman-friendly way of eliciting information and a model of the mutually supportive and non-hierarchical approach which may be regarded as characteristic of women.

The interest focuses on the propositions that (a) women have much 'hidden' understanding, (b) the method helps them to unpack it in a peer group context, (c) reflection is a way of developing one's own practice and (d) the application of learning theory is appropriate.

The influences which emerge from this study are illustrated by reference to those members of the sample group in science or science-related professions.

INTRODUCTION.

It was implicit in setting up this project that in a club for professional and business women there was likely to be a potentially tappable source of wisdom and experience gained in the members' working lives which, if it were to be made explicit, could be used for the benefit of other women.

Questionnaires and/or interviews did not seem to be the methods of choice for obtaining this information because of the time required and there was also the risk of a low response. Moreover, there was a strong incentive to use a method which women would find particularly congenial and least threatening. We therefore looked for a woman-friendly way of eliciting information which could include all members, be easy to set up, be a unifying factor in the club, further the club's object 'to advance the status of women' and be enjoyable.

Only about 25% of the participants could be described as being in science or science-related professions but while, for the purposes of GASAT, we have used the material which they provided to illustrate our findings, in this small sample we could detect no substantial differences between their experiences and those of other women. We have come to believe that the method and outcomes outlined in this paper, while demonstrably of value in exploring the experiences of women scientists, are generally applicable to all women in any kind of employment.

Another factor which motivated us was to show that some useful, relevant data could be generated in a relatively short time. We were able to produce some results, with a practical application, within three months (with Christmas intervening) and the possibility of the project being extended to similar clubs in the region has already been taken up with enthusiasm.

THE PARTICIPANTS

These were 22 members of the Soroptimist International Club of Ipswich and District who volunteered to take part in the project. They represent more than half of the membership which comprises women in a wide range of occupations, not all of whom would call themselves 'professional'.

The purpose of the project was 'To draw on members' own experience to devise a set of guidelines for encouraging the development of other women in employment'.

METHODOLOGY.

To GASAT members, many of whom have spent substantial portions of their working lives 'number crunching', quantitative, statistical research methods and their strengths and weaknesses are very familiar. Many of us are aware that 'our masters' in Government departments, education authorities and other positions of power, are very fond of statistics. Indeed, if one is trying to influence decisions in these quarters, statistics would be the method of choice, since no other appears to have any impact. One of the attractions of statistical methods, is the demonstrable, inexorable (though sometimes flawed) logic with which they focus on the desired outcome. This may mean that they are blinkered to other, possibly relevant but less tractable influences. Sometimes also, the effect of sharp focusing is to produce 'lowest common denominator' information - one always needs to know more. To take an absurd example, it may sound encouraging to hear that there has been a 50% increase in the number of women reading marine engineering in a university department but what if this means 3 individuals rather than 2! In such a situation, would it not be more productive to talk to those women and perhaps discover what factors enabled them to make an atypical choice? It might then be possible to use these data to open up the options for other young women.

In this small piece of research, therefore, we have chosen to use qualitative methods, in the belief that these are much more sensitive instruments with which to tap into the richness of women's wisdom and experience. We are now even more convinced, from the results of this study, that not only do women feel able to share their experiences in a 1:1 discussion with another woman but they positively enjoyed doing so.

The method outlined below, does, we believe, produce insights into women's lives which would not be so accessible in other ways. These insights, we hope, will help us to help other women in their workplaces.

ORIGINS AND DESIGN OF THE PROJECT

Producing a paper for GASAT 7 has stimulated for us the sort of reflection on which the whole project was based. Furthermore we have been intrigued to recognise how often its development has mirrored the patterns and influences identified by participants in the development of their working lives.

The initial idea was sparked off by a phrase, 'a fledgling policy' (attributed to Brenda Dean, a British Trade Union leader) which GS had always hoped to find a way of exploring. When the Soroptimist Club was looking for a new activity she proposed the project. Once accepted in principle, responsibility for overseeing it passed to the Service Sub-Committee, chaired by AW. As co-leaders of The project we brought together two different sets of ideas about methodology which pad been evolving against our different backgrounds. AW's interest in qualitative research (outlined above) provided a theoretical framework; GS's work on reflective practice as a trainer in education brought pragmatic pointers to process (Bolton, 1987; Schon, 1983). Interestingly, we did not at first recognise this and it took a remark from the club president, 'Gill is always talking about peer support. Why not use pairs?' to clarify a way forward.

The creative influence of a phrase which catches the imagination; the question, 'Was it luck or was it being prepared and ready to spot an opening?'; the way in which threads eventually come together, the insight from a simple, challenging remark from someone standing one step back; all these occur repeatedly in the reflections of the women looking at influences on their lives.

In a project which put each participant in the role of researcher, clear, well presented documentation was crucial. After a pilot run of the process as a pair ourselves, we presented draft documentation to the Service Sub-Committee, which made important amendments. All references to 'career' and 'progress' were replaced by 'working life', 'employment' or 'development' and the wording of the purpose changed to support for 'other' rather than 'younger' women. This indicated a wise sensitivity to the need to use vocabulary with which all women would feel comfortable. They also removed from the guidance notes an offer of support, by implication counselling, should the process of remembering be too painful.

This we believed to be a real risk but the Sub-Committee felt that to -mention it in advance was unwise. We should like to record our gratitude to the Sub-Committee and to all other club members who contributed to the project.

THE PROCESS

The process was carefully structured. This was mainly to provide a secure framework within which participants would feel safe to take the risks implicit in reflecting and sharing but also to ensure some standardisation in the format of the reported outcomes. Participants were asked to work through four stages:

- Step 1 Setting up
- Step 2 Individual reflection
- Step 3 Sharing with a partner
- Step 4 Sharing your findings To these was added one further stage to assist us in the writing of our report
- Step 5 Individual review

As this was an afterthought, it was completed by only a third of participants.

STEP 1 SETTING UP

The process began with a briefing session for all club members present as part of a regular club meeting. This involved an explanation of the purpose of the project, the process to be followed, the principles underpinning it and the skills involved. There was particular stress on ground rules to encourage trust, confidentiality and ownership. At the end of the briefing session individual club members decided whether to take part in the project, chose a partner and set up dates for the next two steps. There were some present who did not wish to be involved but we did not feel it appropriate to enquire into their reasons.

STEP 2 INDIVIDUAL REFLECTION

Each participant was asked to reflect on her own on the history of her working life and the reasons why it had developed in this way. To structure this reflection she was asked to fill in a '3D CV', a working document with three columns:

- an outline of jobs held
- experiences and influences connected with working life
- experiences and influences connected with personal life

Participants found little difficulty in completing this sheet and reported both enjoyment and surprise at the recognition of patterns which they had never noticed. For some women this reflection represented the sort of emotional risk which we had envisaged. One reported that it was the first time that she had dared to think about a much loved career from which she had retired years ago. Others worked through memories of painful personal and professional losses and experiences seen as failures. We have no knowledge of any distress which could not be handled but this is no guarantee that it was not experienced.

STEP 3 EXPLORING WITH A PARTNER

Pairs were asked to meet and to explore each partner's reflections in turn. Stress was put on the need to concentrate on one at a time, however similar their experiences might at first appear. The key task of the partner was to listen, seeing herself as a sounding board rather than an interviewer. The ownership of the material must remain firmly with the person speaking; she had control of the breadth and depth of the conversation and it was her task at the end to draw from this shared reflection her insights into the most significant influences which had helped to determine the pattern of her working life. The partner was there to support the process of exploration, and clarification.

Each participant was asked to record her insights on a Findings Sheet with three sections:

- What people did to encourage/help me
- What I did to help myself
- What, in retrospect, I wish I or other people could have done to help my progress

These were the only data to be submitted to us.

All pairs found this stage extremely enjoyable and consistently demonstrated a very high degree of trust and openness across a range of varied pairings. The process outcomes look likely to be an asset to the club, with the structured task helping people to engage with each other at a deeper level than usual. Several reported that their partner had helped them to trace significant threads, thus carrying forward the process which they had begun on their own. Being allowed to share someone else's experience was seen as a privilege.

STEP 4 SHARING YOUR FINDINGS

For the satisfaction of the participants it seemed important to provide an opportunity to share experiences. Part of the next club meeting was given over to group discussions. Again this was fun. A record was made of the main themes identified in each group and added to the data provided by the Findings Sheets.

STEP 5 REVIEWING THE PROCESS

The small number of participants who completed the Individual Review Sheets provided illuminating feedback on their reactions to each step of the process. This will be seen as an essential element, built in from the start, if the project is repeated. They were also asked to suggest possible future activities for the club, arising from this project. A number of ideas was advanced.

BEST COPY AVAILABLE

OUTCOMES

Built into the project was an undertaking to produce a report and 'a set of guidelines for encouraging the development of other women in employment'. This was undertaken by us as co-leaders but, if the project were repeated, we believe that it would be more in keeping with its collaborative nature, and probably more effective, to work with a group on this task.

The data from the Findings Sheets and discussion records were analyzed; six main themes were identified:
- Giving direct, specific advice.
- Believing in me, accepting me, helping to build up my confidence. - Giving moral support.
- Facilitating.
- Role models, peer group influences and examples.
- Coaching and mentoring.

Each individual finding was classified under one of these headings. Very little appeared under the first, suggesting that participants did not remember specific advice as very significant. The next four categories were roughly equal but with 'Coaching and mentoring' twice as long.

The next task was to 'turn round' the findings in order to translate them into guidelines suggesting ways in which we could give support to other women. We frequently quoted the actual words written down so that communication was as direct as possible.

The resulting list was long but at this stage it did not seem appropriate to prune it. Our approach meant that it would have made no sense to give more weight to points produced by several participants. If only one person reported that something had been helpful and relevant to her development, then that might be just what another woman would need in the future.

EXAMPLES TO ILLUSTRATE OUTCOMES

The following selection from the guidelines is derived from the findings of the six 'scientists'. They are addressed to us as women in our various roles; mother, daughter, friend, colleague, manager, public figure, passing contact, all recognised as influences by participants.

- Convey the message that there is nothing a women cannot do.
- Recognise where they were not helped to develop confidence in childhood. Consider if you can do anything to compensate for that lack.
- Don't assume that because a woman is successful she does not need support.
- Help women to come to terms with their 'guilt' or their 'despair' over the conflict between job and family demands.
- Give support to those battling against male dominated systems.
- Help women to think through the personal cost of 'success' in today's world and to make conscious, informed decisions about what they want.
- Encourage them to have wider experiences outside work. These may be the key to the next stage in their career.
- Nominate promising people for committees or working parties.

- Make girls and women aware of successful role models relevant to them.
- Remember that you are a role model to someone - what you <u>are</u> matters.
- If you are really enthusiastic about something let it show; it's contagious.
- Challenge them if they're inclined to rest on their laurels; say 'Aim further'.
- Groom people for promotion by giving them opportunities to widen their experiences in the organisation.
- Acknowledge the work of team members; do not take credit for this yourself.
- Target male colleagues to get them to take younger women's work seriously.

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A FEMALE VIEW ON THE DESIGN OF INFORMATION SYSTEMS

Cecile K.M. Crutzen

La première chose à faire dans l'élaboration et la mise en oeuvre d'un système d'information est de concevoir des modèles du monde réel (d'une partie de ce monde). La modélisation est l'abstraction de phénomènes du monde réel. Une analyste conceptrice ou un analyste concepteur utilise des filtres pour observer le monde. Son opinion influence grandement les étapes initiales et fondamentales de la mise en oeuvre du système d'information. Une fois sur pied, le système d'information se fond dans le monde réel, comme un objet invisible. En outre, ce système d'information dissimule et remplace une partie du monde original. Ainsi, toute modélisation visant la création d'un système d'information contribue à modifier le monde réel. Le cycle de la conception, de la mise en oeuvre et de l'emploi de systèmes d'information est de plus en plus courant. Les systèmes d'information sont invisibles. Leur nombre et leur influence augmentent rapidement. Par conséquent, un nombre de plus en plus important des parties du monde réel ou des diverses perceptions du monde réel disparaissent sans laisser de traces. De plus en plus d'opinions du monde s'effacent. Étant donné que les sciences de l'information demeurent un domaine traditionnellement dominé par les hommes, il est possible que l'opinion féminine dans le monde réel soit de moins en moins prise en considération. La modélisation est une tâche intellectuelle, c'est une activité qui comporte différents aspects, selon le sexe. Dans ce document, nous parlons de la façon éventuelle d'élaborer et d'avoir recours à des méthodes de modélisation et de mise en oeuvre des systèmes d'information telles que les opinions féminines ne disparaissent pas. «En tant que féministes, nous avons le devoir de combattre les abstractions de différentes façons, en notant qu'elles sont historiquement spécifiques, et non pas éternelles; ancrées dans les expériences masculines, et non pas universelles; partiales, et non pas neutres. Ce que nous voulons, c'est rendre visible l'invisible». (Leigh Star, 1991) (Traduction libre)

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A FEMALE VIEW ON THE DESIGN OF INFORMATION SYSTEMS

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Abstract

The first step in the process of designing and implementing an information system (IS), is making models of (a part) the real world. Modelling means abstraction of phenomena in the real world. A system analyst and designer will use filters for looking at the world. Her/his view will extremely influence the initial and fundamental steps implementing an IS. With its realization the IS will become a part of the real world, too, but this part will be invisible. Moreover the IS will hide and replace a part of the original world. So, any modelling for the purpose of realization an IS will change the real world.The cycle of design, implementation and usage of IS's happens mostly again and again in increasingly shorter periods. IS's are invisible. Their number and influence are growing fast. So more and more parts of the real world or the various perceptions of the real world will become invisible. More and more views on the world will vanish. Because computer science is still male dominated, it could happen that the female view in the real world is diminished. Modelling is a mental task, is an activity having gender dependent aspects. In the paper it will be discussed how it may be possible to develop and use methods for modelling and implementing IS's to provide that female views will not get lost. "As feminists we are led to battle with the abstractions in several ways: noting that they are historically specific, not timeless; grounded in male experience, not universal; biased, not neutral. We want to make what the abstraction has hidden, visible." (Leigh Star, 1991)

1. Introduction, views on information systems, invisibility

The purpose of this paper is not to expatiate on the discussions to give a final answer to the questions: 'What is information?' or 'What is an IS?'. In the literature the given definitions of information and IS's depends on what aspects of IS will be discussed. A minimal interpretation of the concept 'information system' is that of a system for data storage, where you can 'write in' data and from which you can 'read out' data. Mostly nowadays IS's have the capability to manipulate the data which were put into the system. So, an IS can be described as a concrete system composed of physical phenomena such as people, hardware, software, sets of data and procedures for the collection, the processing, and the distribution of data. We can also look on the concept of IS by looking at the function of the IS. Throughout all ages people have expressed their feelings, experiences, wishes, and purposes by transferring them to other people. The exchange of information, the communication, they

did in a verbal and non-verbal way. IS's have the purpose of supporting or replacing the spoken or written human communication. Therefore a second view on IS's can be given by conceiving an IS as an abstract system, a reflection of the real system or organization where the IS is a part of. This second view will be used throughout this paper.

Phenomena in our real world become invisible for persons, when it is impossible to get knowledge about these phenomena by their behavior and with the support of technical resources. With behavior not only "observation" is meant but also "experience (perception, acting, feeling, smelling), thinking (reflection, deduction, questioning, imagination, (day) dreaming), and transfer from other people (co-behavior, ostentation, communication)." (Lindgren,1990) The knowledge transfer from other people about phenomena is not always a guaranty that phenomena do not become invisible. For instance in the history of women there are many examples of invisibility. Knowledge transfer by other people about a phenomenon can give you a very specific view on that phenomenon, which could be very different from your own view. Other people could be 'blind' for specific aspects of it in the real world.

Phenomena or some aspects of them become invisible when they are hidden or when they are not perceptible. That does not always mean that the phenomena do not exist anymore. Invisibility is one of the causes that a phenomenon, its behavior, or the perception of it changes to make it visible again. But the changes can be so radical that it becomes very difficult to make the original nature of the phenomenon or the various perceptions of it visible again. Advertising, for instance with tv-commercials, is an example which causes effects of invisibility; despite the fact that the view on the real world represented in the product of advertising, the advertisement, is visible. IS's, too, cause effects of invisibility by transferring information about the real world. But in contrary to advertisements their inner world, especially the representation of the contained view, is invisible.

2. The modelling process

2.1 The link between modelling process and the resulting model

IS's do not appear out of nothing. They have to be designed, to be built and to be implemented. The first step in the design process is making models of the real world. Especially to make a model of those parts, where the IS should communicate on, and where the IS is a part of: the organization. Because the IS itself is a part of the real world, it is obvious that its model of the real world should contain a model of the IS itself (self-model).

The important components in the process of modelling are the real objects in the problem domain, the phenomena in the universe of discourse, the environment of that universe of discourse, the analyzers and the users of the IS, and the most important part: the relations between these components. The modelling process is a phenomenon that takes place in that part of the real world which is the universe of discourse. Implementing the design process gives the IS a higher potential of visibility. So, if the content of the IS should be complete then it should have a representation of that design process. The consequence is that during the process of analyzing, modelling, design, and implementation of an IS; the process itself should be modelled, too. Modelling is a working process. "Work is the link between the visible and the invisible. Visibles are not automatically organized in pregiven abstractions. Someone does the ordering, someone living in a visible world." (Leigh Star,1991) In the opinion of Susan Leigh Star it is not always necessary to "restore the visible". By not forgetting the 'work' you can always make the invisibles visible again. Remembering the working process is in my opinion only a necessary condition. Not every working process or the representation or conception of it has the property of reversibility. A way of remembering is to recognize the design process as a part of the world, to model the design process, and in the last phase to implement in the designed IS the relations between the definitive design and the design process. Trying that is making the content of the IS more objective; objective in the sense of dynamic objectivity and not in the sense of static objectivity. Dynamic objectivity is "the pursuit of a maximally authentic, and hence maximally reliable, understanding of the world around oneself. Such a pursuit is dynamic to the extent that it is actively draws on the commonality between mind and nature as a resource for understanding. Dynamic objectivity aims at a form of knowledge that grants to the world around us its independent integrity but does so in a way that remains cognizant of, indeed relies, on our connectivity with the world." (Fox-Keller,1985)

Implementing the relation between the design process and the design means that a single IS could contain various representations of one universe of discourse. Then it will be the decision of the users, which representation or combination of representations is the most effective in their current situation. Designing the usage of an IS as a decision process forces the users to look at the world and make invisible phenomena visible again. They need "to listen to the material" itself. (Fox-Keller,1985) If the intention is to implement the link between the invisible and the visible in the IS - the working process of the design - we need

to have a closer look at the process of modelling and the methods, which are used in that modelling process. If the modelling process gives no guaranty for a dynamic objective view on the world, the implementation of the design will be based on a static world view. But then it will not contribute to a more effective objectivity of IS's.

2.2 The components of observation

Modelling means doing observations, making experiences, and making representations of both. First at all you have to realize which components of the real world you will observe or experiment with. The important components of that observation should be: the phenomena, their state, their behavior (including their communication), their identity, their relations to other phenomena, the organization where the IS will be part of, the environment of that organization, the cause (mostly a problem) of starting the design process, the analyzer and designer of the model, and last but not least the users of the IS. Moreover not only the modelling process itself but also the motivations, reasons and purposes for the component's representations must be made explicit in the real world model.

Most modelling methods make only models of the phenomena in the problem domain. With some methods for analyzing, it is possible to model users, but usually only for the purpose to implement a good interface between IS and user. There are no modelling methods which models in a holistic sense all of the above mentioned components together. For instance not modelling the analyst and not implementing her/his view means that the process of modelling - the work of the analyst - will get invisible.

2.3 The position of the analyst

The position of the analyst towards the world she/he observes is in (computer) science often the position of a "knower" towards the "knowable". "The relation specified between knower and known is one of distance and separation." (Fox-Keller, 1985)

Making this relation in the modelling process an object of study in the sense that this process is a part of the problem domain will shorten the distance and will break off the separation. User and analyst then have an equal position in the design process. Both are knowers and knowables. Participatory design is a concept for a design process that has some of the necessary conditions for that balance. Participatory design "asks systems developers to put three issues in the forefront of their efforts: focusing on the whole workplace and the actual practices of the people doing the work; involving office workers at all levels in articulating their needs and expressing their concerns for what computer support they may need; and

focusing on the whole workplace and the actual practices of the people doing the work; developing new methods that help developers and office workers actively support ongoing social processes." (Greenbaum,1991) The issues mentioned by Greenbaum are necessary conditions in the process of modelling. But that is not sufficient. An analyst will in that design process still use filters for her/his observation. Filters which are not objective but mostly subjective and determined by the experiences of the observer. It is an illusion to think that analysts are objective observers (in the static and dynamic sense). Therefore an analysis of the used filters is necessary. Analyzing the used filters is a working answer to the questions of Susan Leigh Star: "Do we want inclusion, revolution or new global order?".(Leigh Star,1991) Looking at the used methods in computer science perhaps we could find the direction of the domain in which we have to start a revolution. At this moment it is wise to follow the advice of Harding and Fox-Keller: "To locate the possible directions within which a feminist science could emerge, we should look instead to the distinctive theories of knowledge already being developed." (Harding,1986) "To the extent that science is defined by its past and present practitioners, anyone who aspires to membership in that community must confirm to its existing code. As a consequence, the inclusion of new members, even from a radically different culture, cannot induce immediate or direct change. To be a successful scientist one must first be adequately socialized." (Fox-Keller, 1985) Socializing may not mean forgetting or neglecting your own (female) view on the practice of computer science. Socializing means learning to speak and to understand the language of the present practitioners, thus making it possible that there could be communication on the practitioner's views. Communication is the most important condition to change computer science. Communication is a bridge between the inner world and outer world. On that bridge different views on the real world and on computer science can be discussed and eventually changed. Socializing is a working process, too. Therefore it is necessary to analyze and to remember this process, especially that of women, to make it possible to restore the original view of persons, who have become insiders in the computer science.

2.4 The methods of the analyst: filters in the modelling process

The analyst uses filters for selection and abstraction. These filters are representations of the view of the analyst. In computer science "we are constantly wrestling with the properties of visible things: they are many, they are resistant to our attempts to change them, they clutter our landscape everywhere. In facing the tyranny of blind empiricism, however, we temper

the clutter of the visible by creating invisibles: abstractions that will stand quietly, cleanly and docilely for the noisome, messy actions and materials" (Leigh Star,1991).

The selection filters

1. The selection of the problems or the kind of problems which can be solved.
2. The selection of the domain which will be observed and modelled. This selection depends on the analyst's perception of the problem(s).
3. The selection of the border of the problem domain. Choosing the border of the domain means choosing what part of the world will be represented in the IS and what remains as the problem domain's environment.
4. Choosing the kind of problems that the IS has to solve.
5. Choosing the model of the solution out of many possibilities.

Each representation of an analyst's view has to contain a representation of such a filter set. Implementing more than one of these filter-sets inside an IS could make the system more objective. The border of domain and environment is not a static border because it does not depend any more on the view of one specific analyst. The users are enabled to choose between various views. Even the various views on the real world of the users could be implemented. This concept of a user-view is broader than it is defined usually in the literature. There the user-view of an IS is derived just from the implemented model (which contains only one analyst view).

On the one hand the reliability of an IS could be enlarged by implementing various views and using them comparatively. On the other hand the consistency of an IS might be diminished by giving cooperating users the opportunity to choose between different views. Therefore it is necessary to develop interfaces between the various views.

The abstraction filters

Modelling the real world or a part of the real world means to make abstractions of the objects, situations, processes, events, in a word the phenomena of the real world. Abstraction in science and in computer science is a fundamental way of coping with complexity (Booch,1991). Abstraction is also a process of suppression, as Shaw defines abstraction as "a simplified description, or specification, of a system that emphasizes some of the system's details or properties while suppressing others" (Shaw,1984).

Abstraction filters can be described as classification, generalization, and aggregation. By classification the phenomena of the real world are reduced to object types with a limited

amount of properties, and these properties have a limited amount of values. Hoare suggests that "abstraction arises from recognition of similarities between certain objects, situations or processes in the real world and the decision to concentrate upon these similarities and to ignore for the time being the differences." (Dahl, 1972). It follows that abstraction leads to ignoring and suppressing the differences between phenomena which are not relevant in the view of the analyst. Object types are made by the search of similarities. Differences are mostly neglected because they are not easy to handle. Giving more appreciation to the differences of phenomena in methods for design and modelling could be a source for finding balanced methods. As Suchman said: "the appreciation of difference itself can become a source of solidarity and agenda for social change" (Suchman,1991). The representation of phenomena in the IS should not only be based on the decision to put some phenomena into one class because of similarity but also on the decision to put some phenomena in different classes in spite of similarity. The methods of abstraction and especially classification should maximize reciprocity and appreciate difference. Not only the analysis methods should have these characteristics. But the persons involved in the modelling process must have "the other incorporated into the self rather than dominated and/or repressed." (Harding, 1986)

The process of modelling can only be objective and has the potential of visibility, when the analyst is incorporated in the problem domain and she/he has incorporated the problem domain in oneself. Especially this means that the analyst has to incorporate the user and the user has to incorporate the analyst.

The complementary activity to classification is instantiation. Instantiation means to give a description of class elements. By instantiation every object in the IS gets a state, exhibits some well-defined behavior and has an unique identity. An instance is the representation of an individual phenomenon out of the real world in the IS. So real, individual objects correspond to instances of object types in the model. Real objects are made partly invisible, because only the elements of relevance to the analyst will be represented. A real phenomenon can only have a representation in the IS when it fits into a class. This sequence in the modelling process - first classification and then instantiation - makes it happen that some phenomena are incompletely or not at all represented. Incompleteness means invisibility for the users of the IS. The more as classification is based upon similarities and not upon differences. The concept of classes has the same effect as the concept of laws of which Fox-Keller noted "Such laws imply an a priory hierarchy between structuring principle and

structured matter that suggests a striking resemblance to laws of authoritarian states." The class structure will suppress "listening to the material itself". (Fox-keller, 1985)

The hierarchical patron of this analyzing process is reinforced by the concept of inheritance. Inheritance defines a relationship among classes where one class shares the structure or behavior defined in one or more other classes (single and multiple inheritance). Inheritance is the concept for `the kind-of hierarchy` (generalization/specialization) or for `the part-of hierarchy` (aggregation). "To have no inheritance in your design every class would be a free-standing unit, each developed from the ground up. Different classes would bear no relationship with one another, since the developer of each provides methods in whatever manner he chooses." (Cox,1986). Models with no inheritance are models with a lack of economy and therefore are considered as inelegant. But the appreciation of inheritance reinforces the hierarchical patron of the model. It makes it possible to define virtual classes. Classes which are no representation of real phenomena in the real world. So, inheritance will also enforce the invisibility. The appreciation of inheritance will provide neglecting non-hierarchical relations between phenomena in the real world. We have to find modelling methods where there is a balance between hierarchical and non-hierarchical relations.

Dealing with complexity means in computer science finding a hierarchic structure in a real world system. Complexity is defined by hierarchy; "the fact that many complex systems have a nearly decomposable, hierarchic structure is the major facilitating factor enabling us to understand, describe and even 'see' such systems and their parts" (Simon, 1982)

By recognizing that the modelling process as it is practiced at the moment is strongly hierarchic, hierarchic in the position of the analyst towards the world of observation, hierarchic in the steps in the design process; classification and then instantiation, and hierarchic in the product (the appreciation of inheritance) we did the first step in finding the directions of changes. We have to learn to 'see' and to 'represent' the various non-hierarchic structures; "indeed it is likely that we can understand only those systems that have a hierarchic structure" (Booch, 1991)

3. Conclusions

As the IS should be a complete representation of the whole organization, then we have to find methods to model and to implement not only the public and rational, but also the private, emotional aspects of the phenomena in our world. "Skills such as reasoning and objectivity became associated with public life, and feeling and subjectivity with private life. These

dichotomies have become historically associated with the development of distinctive feminine and masculine world views." (Wajcman, 1991). As a computer scientist and as a woman I have incorporated these dichotomies in myself. In this paper I have tried to make this visible by making my view on the current design strategies explicit. By making my view visible for myself, I could think about directions in which computer science could (should) change. Perhaps then it may be possible that the content of an IS is a representation of a real world, where hand, brain and heart are united. As female computer scientists we are obliged to do so because: "The feminist theory of knowledge differs from the perspective of man's distinctive activity and experience.... Its distinctiveness is to be found in the way its concepts of the knower, the world to be known and processes of coming to know reflect the unification of manual, mental and emotional ("hand, brain, and heart") activity characteristic of women's work more generally." (Harding, 1986)

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A CRITICAL-FEMINIST PERSPECTIVE ON SECONDARY SCHOOL WORK EDUCATION CURRICULUM

Janice Ahola-Sidaway and Margaret McKinnon

De nos jours, les jeunes femmes peuvent s'attendre à passer une bonne partie de leur vie à travailler et c'est pourquoi il est important qu'une éducation adéquate les prépare à cette réalité. Certaines des jeunes femmes qui arriveront sur le marché du travail dans la prochaine décennie trouveront des emplois dans des professions libérales et de gestion; toutefois, beaucoup d'entre elles accepteront des postes de col bleu ou rose dans les secteurs de bureau, des ventes, des services et de la manufacture. En tant qu'éducatrices et éducateurs, nous devons d'examiner nos obligations face au grand nombre de femmes qui quittent l'école après avoir obtenu leur diplôme d'études secondaires, ou avant, pour travailler dans ces secteurs. Ce document traite de la question de la réforme de l'éducation professionnelle dans les écoles secondaires d'un point de vue féministe, en l'associant directement aux réalités des milieux de travail auxquelles font face les femmes qui occupent des emplois de col bleu ou rose.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

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ABSTRACT

Young women today can expect to spend a major part of their lives in the paid workforce and they need appropriate education to prepare them for this reality. Some of the young women who enter the labour force over the next decade will find jobs in professional and managerial occupations; however, many others will work in pink and blue collar jobs in the clerical, sales, service and manufacturing sectors. As educators, we need to examine our obligations to the large number of females who leave school at or before high school graduation to join the ranks of women working in these jobs. This paper addresses the issue of secondary school work education reform from a critical-feminist perspective by linking it directly to workplace realities that women face in pink and blue collar jobs.

Introduction

Our discussion draws attention to three workplace issues for current and future female workers employed in pink and blue collar jobs in the clerical, sales, service and manufacturing sectors. These three issues are: occupational sex segregation, job value, and job security. It is important to point out, however, that by highlighting these issues from the point of view of this segment of the workforce, we are not suggesting that individuals of other occupational groups--whether male or female--do not face these challenges. What we are suggesting is that we need to begin to broaden our discussions about how to educate students about the world of work, and that workplace realities for women in pink and blue collar jobs need to be incorporated into that discourse.

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Workplace realities for women in pink and blue collar jobs

Despite their increased participation in the workforce, women world-wide still remain segregated according to their sex rather than their abilities. In particular, women are clustered into the clerical sector. For example, in the U.S. and Canada, approximately one in three working women holds a clerical position, making it overwhelmingly female in composition and by far the leading occupation for women in both countries (Ferree, 1987; Labour Canada, 1990).

In occupations that are less female-dominated, women are clustered into specific occupational niches. For example, in the sales sector, women are often employed as sales clerks selling less expensive, high volume items such as clothing, rather than more expensive items such as cars or appliances (Broadbridge, 1991; Faludi, 1991). In the service sector, women working in retail grocery chains, are more likely to work in lower-paying positions such as cashiers, meat wrappers, and deli clerks, than in higher-paying jobs such as bakers, meat cutters, or produce clerks (Cuneo, 1990). In the blue collar area, women tend to be clustered into so-called "unskilled and semi-skilled" positions in the light industrial and labour intensive sectors (Rosen, 1987). Even where women have attempted to enter non-traditional occupations, they have often faced resistance in the form of re-segregation into female niches, harassment, or blatant hostility (Reskin & Hartmann, 1986).

Besides being segregated into lower-paying occupational niches, women working in pink and blue collar jobs often find that their work is undervalued. Many of the visible and invisible skills that these women need to carry out their jobs are neither recognized nor rewarded. For example, in the clerical, sales, and service sectors, many women are required to perform, but are not compensated for, "emotional" labour (Machung, in Carter, 1987), namely being cheerful and friendly, in order to maintain a pleasant, smooth-running working environment. In blue collar production and assembly work, participant observers working in garment factories have seen and felt first hand the complex, yet undervalued, skills needed to carry out their low-paying jobs. The social valuing of health and safety issues, both domestically and off-shore, also tend to be underestimated for female workers. For example, sales and service jobs, which often require women to stand without moving for long periods of time, have become increasingly monotonous and fast-paced with the

introduction of technology such as computerized cash registers and menus. The widespread practice of at-home work, an arrangement which appears to offer women a workable solution for balancing the need to earn wages and to care for children, contributes to additional devaluing. At-home workers often do not receive even the most basic of employee benefits, work agreements often include short dead-lines and piece-rate wages, and there are few opportunities for contact or collective action with on-site or other at-home workers.

Another factor that negatively affects women working in pink and blue collar sectors is job vulnerability. Companies are increasingly seeking out cheaper labour pools, both domestically and off-shore. Because women, more so than men, are considered as part of the reserve labor force, job losses for women workers typically do not generate much media attention (Faludi, 1991; Rosen, 1987). However, the reality of job displacement, unemployment, and re-employment at lower wages is one that women working in the pink and blue collar sectors face with increasing regularity as companies relocate and restructure their workforces. What's more, the growing and widespread trend towards contingent work contributes to increased job insecurity for full-time and part-time workers, as it shifts production risks to workers, eliminates opportunities for collective action, and restricts access to company benefits. This trend carries particular significance for women workers in that they are much more likely than men to be part of this workforce.

Working women and their advocates continue to struggle to improve working conditions for female workers. However, despite the gains made, pervasive occupational sex segregation, work devaluation, and basic job vulnerability continue to characterize the working contexts of many women in pink and blue collar jobs; and there are many indicators to suggest that these issues will remain problematic. In the 1980's, the pace of occupational desegregation slowed; what's more, in some occupations, sex segregation became even more pronounced (Reskin & Hartmann, 1986). Current trends in the world of work (e.g., new technologies, off-shoring or sub-contracting of work, the growth in part-time work and small business enterprises) threaten to further erode job value and job security for female workers.

Today's secondary school students need to be fully informed about these issues. Many of these students will work in pink and blue collar jobs; others will pursue careers

that will directly or indirectly influence the future of that labour force. The following discussion explores how secondary schools can foster the goal of helping secondary school students to become more knowledgeable about these issues.

Reforming secondary school work education curriculum

In North America, ideas as to how secondary schools should proceed in educating students for the world of work date back to the early years of this century (Snedden & Dewey, 1977/1915). Recent calls for reform to secondary education in general, and work education more specifically, have stressed the need for today's students to acquire basic literacy and numeracy, basic technological competence, strong interpersonal, conceptual, cooperative, and problem-solving skills, and the ability to adapt and learn as working contexts shift (Economic Council of Canada, 1992; Gray, 1991).

As important as these goals are in the education of students for the world of work, we believe that our responsibilities as educators go even further; and therein lies the major shortcomings of this reform discourse. In our view, it is not sufficient to portray the goal of work education as a singular struggle to shape students into human resources that will serve the needs and interests of their future employers and the economic agendas of national governments. Worker socialization cannot be the only goal; the workplace itself needs to be the object of inquiry if it is to be transformed into a more socially equitable and just setting. What's more, the mainstream work education reform literature does not demonstrate knowledge about, much less sensitivity to, issues of particular relevance to the current and future female workers--especially those in clerical, sales, service, and manufacturing jobs.

The critical and feminist pedagogies literature offers directions for curriculum reform which includes a critical examination of workplace issues. Researchers within these perspectives (e.g., Gaskell, 1992; Shilling, 1989; Simon, Dippo, & Schenke, 1991) call for educational initiatives that will help students critically examine the contradictions, realities and inequalities of the workplace. They argue that we need to develop educational practices that empower students of all ethnic and social class groups by helping them to examine dimensions of work such as the sexual division of labor, the hierarchical nature of the workplace, the power relations among workers, and the benefits and limitations of working

conditions. The emphasis in these educational practices is to encourage students to ask questions, to reflect on their own everyday realities inside and outside school, to examine taken-for-granted assumptions about men's work and women's work, and to consider alternative structures and practices which will contribute to a more equitable power-sharing within and across communities.

The workplace realities that we discussed earlier in the paper reinforce and add to these critical discussions of work, particularly from the point of view of sex segregation, job security, and job value. Some secondary schools have programs that could, and in some cases already attempt to, provide opportunities to learn about these issues. The following discussion focuses on two curricular contexts where students can explicitly learn about the world of work: male-dominated technical courses and female-dominated technical courses.

One way to address the gendered nature of the workplace is through the male-dominated technical courses offered in work education programs. Adolescent females who enroll in these courses frequently experience discomfort in the workshop settings. Several researchers (Cockburn, 1987; Stafford, 1991) have noted that adolescent females who enter these settings often have to contend with strong male cultures that are resistant (and at times openly hostile) to the integration of females in technical areas. In addition to the unfriendly social environment where sexual harassment, sex segregation and implicit or overt sex discrimination are commonplace, the physical environment in these settings may also contribute to a lack of comfort for female students. Equipment used in the workshops is designed for males; what's more, male students tend to be more knowledgeable about and more experienced with the tools and equipment used in the classes than female students are.

Teachers need to recognize and support the courage that it takes for adolescent females to enter and stay in male-dominated technical courses. These courses offer opportunities to challenge the taken-for-granted gender images of one's society; they challenge not only what constitutes "men's work" and "women's work", but also what it means to be male or female. However, adolescent females should not have to face these challenges alone. Teachers need to be sensitive to the social, economic, and cultural realities of female students that shape their enthusiasm for and their participation in male-dominated technical initiatives.

Teachers can help young women who are considering these initiatives to explore

how re-segregation, inequitable power relationships between males and females, outsider and minority status within the male subculture, discrimination, harassment, open hostility, health and safety risks, and job loss can affect the quality of their working lives both in school and out of school. Peer networks, mentoring programs and special segregated classes with female teachers where adolescent females may be able to talk about sex stereotyping, to explore and to practice techniques without ridicule from boys, to discuss the economic and social costs and benefits of working in male-dominated areas, to examine how images of femininity and sexuality can be reconciled with the demands of doing a "man's job" (Cockburn, 1987; Eden & Aubrey, 1988) could help create more equitable and supportive learning conditions for females within male-dominated technical courses.

In addition to creating opportunities for adolescent females to gain confidence in male-dominated technical areas, it is also important for teachers to work with adolescent males to challenge stereotypical notions about men's and women's work. Cockburn (1987) and others have stressed the need to develop "purposeful" programmes of consciousness-raising that will change the attitudes and behaviours of adolescent males so that it is possible for adolescent females to train along with them in a climate of comfort and safety. Anti-sexist practices that focus on structural constraints that limit equitable distributions of power within the school, the family, and the workplace need to be included as part of this pedagogical agenda with adolescent males.

Female-dominated technical courses also offer opportunities for developing critical-feminist pedagogical activities that include workplace realities. Research has repeatedly shown that the social context of co-educational classes discriminates against females (Delamont, 1990). The segregated settings which typically characterize female-dominated courses such as business education have the potential to be particularly responsive to the concerns, questions, and insights of female students regarding their future roles as wage earners and women.

Although a critical examination of the working context of clerical workers is not typically part of the business education curricula (Gaskell, 1992), with the proper support, these courses could potentially serve as settings for exploring the social context of clerical work, for learning about how the occupation and its incumbents are affected in terms of sex

segregation, job devaluing, and job vulnerability. Given the proper resources (e.g., a supportive school culture; in service education; adapted curriculum guidelines and materials; closer links with female clerical advocates) teachers could encourage their students to examine the history and pervasiveness of sex segregation within the clerical field, the low pay that characterizes the occupation, the invisible and more visible skills that make up different clerical jobs, the health and safety issues linked to clerical jobs, and the exploitative aspects of back office sweatshops, at-home clerical arrangements, and part-time positions. Teachers could provide their students with opportunities to learn about the struggles and gains within their occupation through arranging meetings with clerical advocates. They could also encourage their students to examine their local, familiar surroundings (e.g., the segregated nature of their courses; the segregated and poorly remunerated clerical positions within their own school) to identify pervasive issues related to occupational sex segregation, job devaluing, and job insecurity.

It is also important that the technical training provided within these courses give adolescent females access to the skills and knowledge needed to design and use the new technology creatively. Brine (1992) argues that much of the new-technology training offered to working-class females concentrates on "end-user skills: office-based VDUs, or retail-based electronic tills" (p.159). Teachers can help adolescent females explore opportunities for and barriers to advancement in the new technology areas in traditional female jobs.

In addition to the curricular contexts discussed above where students can explicitly learn about the world of work, there are numerous co-educational opportunities within the curriculum where students could explore workplace issues. Courses that are not primarily designed to provide students with work-related knowledge could nevertheless incorporate this dimension without comprising quality. For example, in Science and Technology courses, students could examine the social impact of technological applications and workplace designs, as well as the health and safety issues affecting pink and blue collar workers.

The resources educators could draw on to help students develop critical-feminist perspectives on the world of work are diverse and multi-vocal. They could include

resources such as meetings with social activists, union organizers and workers, accounts of historical events, life histories, documentaries of female workers, and past and current media accounts of working women. Students' inquiries should also take into account the familiar, taken-for-granted contexts of their own school, community, family and part-time work settings. Many secondary students already have experience with workplace inequities through their participation in the formal and informal youth labour force and through the employment and unemployment experiences of family and friends. As educators, we need to help them see these inequities as pervasive social problems, rather than as individual, local problems.

Work educators who attempt to develop critical-feminist pedagogical activities do not have an easy task. Teachers must, on the one hand, help students develop the necessary knowledge, skills and attitudes that are valued by the workplace, yet on the other hand, must help students become more empowered through critically examining that same workplace. This dialectical exercise is particularly challenging when schools are dependent on the co-operation of the workplace for its placements.

It is important to acknowledge that our discussion has only partially addressed the problem of how to educate students about female pink and blue collar workers. We have not, for example, discussed such important issues as the structural and social constraints within schools that give females (and students in general) very limited power. We have not discussed the intractability of schools that make change so difficult to initiate and to maintain. We have not discussed the second class status--particularly in North America--of all individuals associated with vocational courses. Such issues, among others, also need to be incorporated into critical-feminist work education discourse intended to serve the interests of future female workers.

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LA GESTION DE LA TECHNOLOGIE AU FÉMININ

Isabelle Deschamps

This paper first of all summarizes the issue of the participation of women in technology management, and the probable causes and consequences arising from this, and then goes on to propose in what ways further studies might be needed in order to assess the value of the respective quantitative and qualitative contributions of women in engineering in the area of technology management. The following interrelated phenomena are outlined: (1) Governments and company managers are becoming more and more interested in research and development, and innovative programs in general, due to the globalization of the economy, as well as accelerated technological development. (2) Technological leadership, and the acclimatization of new technologies to the concomitant social and economic environments, will necessitate the emergence of well-informed technology managers, as well as a highly specialized skilled workforce. (3) Engineers are becoming conscious of a more expanded role within the framework of such an area of concern. (4) However, not only is there a scarcity of engineers, but there is also a certain dearth, amongst engineers already in employment, as to knowledge and skills. This is causing concern about the low rate of technological development, and the direction that this development is taking, for the latter is realized by means of methods such as prediction, repetition, and mathematical optimization, as well as a general disinterest in human-beings and ecosystems. (5) Hand in hand with this, women are, by various direct and indirect means, "excluded" from the engineering profession, and from employment in areas of decision-making related to technological development. Supported by the above premises, together with a synthesis of various studies, what is suggested is a model that might serve as a starting-point for empirical research on women engineers managing technology, the ultimate purpose of which would be to conceive a formal body of knowledge militating in favour of the image of women managing technology.

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LA GESTION DE LA TECHNOLOGIE AU FÉMININ

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RÉSUMÉ

Cet article résume la problématique réunissant les femmes et la gestion de la technologie, ses causes et conséquences probables, avant de faire état du besoin de recherches qui valorisent l'apport quantitatif et qualitatif des femmes en génie dans le domaine de la gestion de la technologie. L'on y verra les phénomènes inter-reliés suivants: 1) La mondialisation de l'économie et le développement technologique accéléré augmentent l'intérêt des gouvernements et chefs d'entreprise pour la R&D et l'innovation. 2) Le leadership technologique et l'adéquation des nouvelles technologies aux contextes sociaux et économiques exigent l'émergence de gestionnaires de la technologie avertis ainsi que de professionnels hautement spécialisés. 3) Les ingénieurs voient leur rôle élargi au sein d'une telle problématique. 4) Cependant, il y a pénurie d'ingénieurs ainsi que carence dans les habiletés et connaissances des ingénieurs en poste. On s'inquiète du faible taux et de l'orientation du développement technologique, axé sur la prédiction, la répétition, l'optimisation mathématique, ainsi que la négligence des humains et des écosystèmes. 5) En même temps, les femmes sont, par de multiples moyens directs et indirects, «écartées» de la profession d'ingénieurs et des postes décisionnels en matière de développement technologique. Appuyé sur ces prémisses et sur une synthèse des écrits et recherches, il est proposé un modèle qui pourra servir de départ à une recherche empirique sur les femmes ingénieures qui gèrent la technologie, en vue de développer un corpus formel de connaissances qui servira à promouvoir la femme gestionnaire de la technologie.

INTRODUCTION: LA PROLÉMATIQUE ET CEUX QUI S'EN PRÉOCCUPENT

La mondialisation de l'écolomie et le développement technologique accéléré augmentent l'intérêt des gouvernements et chefs d'entreprise pour la R&D et l'innovation. Des études récentes dénotent le rapport étroit entre la R&D et l'innovation technologique (brevets, exportations de produits de haute technologie) d'une part et la prospérité économique et sociale d'autre part (Deschamps, 1992; Petrella, 1989).

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

En parallèle à ces préoccupations, d'autres opinions et études mettent en exergue les effets prévisibles et imprévisibles, mais néanmoins inéluctables et durables, du développement technologique sur les conditions sociales et écologiques (Diamond, 1991; Petrella, 1989). Le leadership technologique, pour être durable et «acceptable», devrait passer par l'adéquation des nouvelles technologies aux contextes sociaux et économiques, plutôt que par une soumission des membres des sociétés face à la technologie, qui est alors un instrument de pouvoir pour ceux qui la détiennent et en contrôlent l'application et la dissémination, soit les hommes dirigeant les entreprises privées et d'états ou les membres de professions techniques (Pauchant, 1992; Deschamps, 1993).

Depuis le milieu des années 80, il émerge un consensus, au sein de plusieurs groupes, sur l'importance d'améliorer la gestion de la technologie. En premier lieu, chez les groupes en grande partie dirigés par des hommes, les phénomènes suivants ont été des catalyseurs à une volonté de changement: le retard technologique (Harvey, 1990), l'émergence de nouvelles puissances économiques, ainsi que la persistance des problèmes de développement en Afrique et Amérique du Sud. D'autres données récentes, cette fois sur les dommages environnementaux, ont «réveillé» d'autres inquiétudes à propos du développement de «technologies propres», perçu comme nécessaire et exigeant une approche plus concertée et formelle à la gestion du développement technologique (Winter, 1989), en vue de réconcilier les considérations économiques, éthiques et écologiques (Deschamps, 1993). Face à ces préoccupations, les praticiens comme les chercheurs en gestion s'accordent pour revendiquer des approches novatrices et intégratrices à la gestion de la technologie, lesquelles appellent l'émergence d'une nouvelle génération de gestionnaires de la technologie (Caincross, 1992). Ceux-ci seraient plus ouverts, mieux informés, capables de réconcilier de multiples visions et de décider dans l'ambiguïté, favorables à la collaboration intra et inter-entreprises, habiles en transfert technologique, et surtout patients et compréhensifs envers les besoins collectifs comme individuels (Deschamps, 1992 et 1993).

LES INGÉNIEURS ET LA GESTION DE LA TECHNOLOGIE

Les corporations regroupant divers groupes de professionnels, dont les ingénieurs, ont fait écho aux constatations ci-dessus à propos du problème à multiples facettes -- économique, politique, sociale et écologique -- au sein duquel la technologie joue un rôle d'avant-plan. Par exemple, l'Ordre des Ingénieurs du Québec a mis sur pied des «comités spéciaux» d'études à ce sujet. Selon les dirigeants de ces regroupements professionnels, chaque ingénieur, à juste titre, voit son rôle et ses responsabilités élargis au sein d'une problématique intégrant technologie, développement sociétal et croissance économique (voir White, 1990). Ces professionnels occupent une grande partie des postes qui influencent le cours du développement technologique: ils sont chercheurs, concepteurs de produits et de procédés industriels, superviseurs des usines, aviseurs lors de décisions d'investissements, agents gouvernementaux, ainsi qu'éducateurs. Les jeunes ingénieurs s'intéressent encore plus tôt que les «anciens» aux fonctions de gestionnaires. Ils font la queue à l'admission des programmes de MBA. De l'avis même d'une ingénieure représentative de ce groupe:

> *«de plus en plus d'ingénieurs doivent jumeler une solide compétence technique avec une approche administrative articulée. La façon dont les entreprises se structurent autour de projets, la complexité technique des réalisations, la concurrence internationale féroce, l'accent mis sur les ressources humaines, tout invite à aller chercher cette combinaison gagnante»*
> (Lapierre, citée dans Morazain, mars 1992b).

LES CARENCES EN GESTION DE LA TECHNOLOGIE

Malgré les préoccupations et l'ancienneté des ingénieurs dans des postes de gestionnaires, beaucoup de chemin reste à parcourir pour satisfaire, en quantité comme en qualité, les besoins en matière de gestionnaires de la technologie. Premièrement, il y a pénurie d'ingénieurs dans de nombreuses disciplines et secteurs industriels (voir Morazain, mars 1992a). De plus, les cours et programmes à caractère multi-disciplinaire qui prépareraient le mieux les ingénieurs à exercer leurs fonctions de gestionnaires sur

des questions technologiques ayant des portées environnementales, sociales, dans une optique de «qualité totale», sont encore rares, peu connus et très «jeunes», donc loin d'être pleinement opérationnels. À ce titre, une recherche empirique de l'auteure, auprès de 38 ingénieurs et scientifiques chefs de projets de développement technologique dans un laboratoire de R&D canadien, a mis en exergue les problèmes et le sentiment d'impuissance de plusieurs ingénieurs face aux multiples facettes -- politiques, humaines, sociales et environnementales -- des choix technologiques à effectuer (Deschamps, 1991). En bref, l'on sait encore très peu gérer la technologie et le processus d'innovation technologique (Deschamps, 1992).

Cette carence d'habiletés, de connaissances et de programmes de formation des ingénieurs est inquiétante à divers titres et pour divers groupes, incluant les femmes qui aspirent à la profession d'ingénieur ou qui «subissent» les contre-coups d'une gestion «inadéquate» de la technologie: Premièrement, certains experts, la plupart économistes ou hauts-dirigeants, s'attardent sur le faible **taux** de développement technologique (Harvey, 1990). En second lieu, d'autres observateurs s'inquiètent de l'**orientation** du développement technologique, qui est axé sur la prédiction, la répétition, la complexification, la grande échelle, l'optimisation mathématique, soit des idéaux qui font tous en sorte qu'on favorise le rendement technique et la performance économique et qu'on néglige et brime les humains et les écosystèmes affectés (Cooley, 1980; Pauchant, 1992). Troisièmement, plusieurs chercheur(e)s et praticien(ne)s, de domaines divers tels que les arts (Diamond, 1991), l'économie (David-McNeil, 1992), ou la sociologie (Hacker, 1991), ont étudié le même problème sous l'angle des causes et conséquences de la faible représentativité des femmes en génie (p.ex. Ouellet, 1991; Dontigny, 1991). L'on peut induire de ces travaux une association possible entre **les problèmes actuels de développement technologique** d'une part et la **représentativité et le pouvoir des femmes dans la profession d'ingénieur** d'autre part.

LA GESTION, LA TECHNOLOGIE ET LES FEMMES

Associer problèmes «féminins» à problèmes «technologiques» serait «risqué» sans le support fourni par la fusion des divers constats ci-dessous:

1- Les femmes sont, par de multiples moyens directs et indirects, «écartées» des professions reliées aux sciences et à la technologie, et en particulier de la profession d'ingénieur (David-McNeil, 1992): moins de 4% des ingénieurs canadiens (et de 10 à 25% des étudiants inscrits en génie) sont des femmes (Conseil Canadien des Femmes en Ingénierie, 1992; Management Today, 1991).

2- La «culture d'ingénieur» qui prévaut, centrée sur le «mâle dominateur», contribue à maintenir l'écart de représentativité homme-femme en génie: a) dualisme corps-esprit; b) humour à caractère sexiste (voire sexuel); c) séparation profonde entre l'humain, ses valeurs d'une part et la machine d'autre part, fondée sur le taylorisme (Hacker, 1991). Il est même dit que «[...] ... *La Science [est] le système de valeurs du guerrier blanc, mâle et capitaliste*» (Cooley, 1980; cité dans Diamond, 1991).

3- Les femmes ingénieures ou scientifiques sont également absentes des postes décisionnels qui pourraient influencer le cours du développement technologique: elles ont de la difficulté à faire valoir leurs idées (Gordon, Di Tomaso et Farris, 1991) et sont absentes des postes de haut niveau (CCFI, 1991; Leighton, 1992).

4- L'apport distinctif des femmes en génie, et plus particulièrement en gestion de la technologie, est potentiellement très valable, quoiqu'encore discret et perçu comme «anormal» (l'on parle de «contestataires»; Ouellet, 1991; Morazain, juin/juil. 1992).

5- Les femmes ingénieures, en contraste avec leurs homologues masculins, d'après le peu publié, semblent refuser de se «mouler» à la coquille «rationnelle et mathématique» que la profession leur propose (et qui est décriée, tel que discuté ci-haut). Citons une jeune chercheuse, Claire Deschênes:

> «*Pour moi, cela a toujours été clair que je ne voulais pas travailler sur quelque chose qui entre en contradiction avec mes valeurs, c'est-à-dire que je juge*

polluant,ou qui touche le domaine de l'armement. J'aimerais que ce sur quoi je travaill soit utile et que, de mon vivant, cela serve à quelque chose»
(Dontigny, 1991).

La problématique soulevée par les propos et constats ci-haut nous amène à la proposition générale suivante sur les causes, conséquences probables, et solutions aux problèmes interreliés des femmes, du génie, de la technologie et de sa gestion:

PROPOSITION GÉNÉRALE: *Le problème de la femme en génie est intrinsèquement relié au problème général de gestion de la technologie. La solution à ces deux problèmes demande d'une part un élargissement de la vision et des compétences des gestionnaires de la technologie, et d'autre part une augmentation de la représentativité des femmes en gestion de la technologie. Les femmes, pour de multiples raisons, n'exercent pas la profession d'ingénieur (et la gestion de la technologie) de la même façon que les hommes. Pour cette raison, l'élargissement (voire enrichissement) des compétences des gestionnaires de la technologie est présumé comme associé, entre autres, à une meilleure intégration des femmes dans la profession d'ingénieur et à une reconnaissance pleine et entière de leur apport distinctif.*

NATURE, CADRE CONCEPTUEL ET MÉTHODOLOGIE DE LA RECHERCHE

Partant de cette proposition et de ses fondations, nous avons entâmer une recherche sur «les femmes ingénieures gérant des projets de développement technologique», en vue de développer un corpus formel de connaissances qui servira à la promotion de la femme ingénieure et à l'éducation des femmes et des hommes actifs en gestion de la technologie (Lam, 1990). Nous avons d'abord effectué une synthèse systématique des écrits et recherches sur divers thèmes pour élaborer le cadre conceptuel suivant, qui sera testé via l'étude de 50 cas de femmes ingénieures gérant la technologie:

- Premièrement, la problématique de départ est définie comme l'intégration pleine et entière des femmes dans la profession d'ingénieur et dans des postes de gestionnaires de la technologie. Cette intégration se fait via un **processus à quatre étapes**: 1) **accès à la profession et aux postes de gestionnaires de la technologie** (CCFI, 1991; David-McNeil, 1992); 2) **intégration** dans ces postes, par les compromis personnels, les

programmes d'accès à l'égalité, l'influence des gestionnaires en poste, la formation, reconnaissance de leurs compétences (Lam 1990; Leighton, 1991; Gordon et al, 1991); 3) **modification du milieu** par les femmes intégrées dans des postes de gestionnaire de la technologie (Harel Giasson et Marchis Mouren, 1991; Morazzin, juin/juil. 92); 4) **contribution distinctive** de ces femmes gérant la technologie (Rosener, 1990).

- Deuxièmement, en plus de s'intéresser aux facteurs **organisationnels** (p.ex. la taille de l'entreprise), **inter-personnels** (p.ex. le harcèlement) et **managériaux** (p.ex. le sexe du patron), lesquels facilitent ou retardent la manifestation de la contribution significative et originale des femmes en gestion de la technologie, notre modèle (appuyé des tendances récentes dans la recherche en gestion) privilégie l'étude des facteurs **personnels**, soit intrinsèques à la femme ingénieure elle-même: par exemple, ses origines, sa personnalité, son style de gestion, ses habiletés de leadership, etc. (Deschamps, 1992; Harel-Giasson et al, 1991; Lapierre, 1992).

- Globalement, à partir d'une fusion des recherches de multiples disciplines -- p.ex. le processus de changement technologique (Deschamps, 1991); la gestion de projets à caractère technique (Deschamps, 1992); les femmes gestionnaires (Harel Giasson et al, 1991); les habiletés de gestion (Lapierre, 1992)) --, notre cadre conceptuel associe entre elles les variables suivantes: 1) les habiletés de gestion des femmes ingénieures occupant des postes de gestionnaire de la technologie; 2) les caractéristiques des projets de changements technologiques qu'elles dirigent; 3) l'approche à la gestion favorisée par ces femmes; 4) les particularités du contexte de travail créé autour de ces femmes, en fonction des trois facteurs précédents; 5) le succès des projets menés par ces femmes.

Sommairement, en matière de résultats attendus, notre expérience personnelle à titre d'ingénieure de R&D, combinée à la revue des recherches passées et à des entrevues informelles avec des hommes et des femmes en génie actifs en gestion de la technologie, nous permettent d'avancer que la recherche proposé démontrera que les femmes

ingénieures qui ont accédé et pleinement intégré des postes de gestionnaires de la technologie possèdent à un degré élevé les habiletés reconnues comme promotrices d'une gestion améliorée de la technologie: communication, délégation, esprit d'équipes, valeurs humaines, habiletés à régler les conflits. Une étude empirique qui confirmerait ces hypothèses appuirait la lente ascension des femmes vers la mixité, servirait la cause du génie et favoriserait un développement de technologies plus «appropriées» (Winter, 1989).

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SUMMER SCIENCE & TECHNOLOGY PROGRAMS FOR YOUNG WOMEN

Nancy Cook, Cinda-Sue Davis, Mary Ann Evans, Ellen Mappen,
Elizabeth O'Connell-Ganges and Kathleen Sullivan

Des programmes d'été de sciences et de technologie pour les jeunes femmes de cinq universités américaines seront présentés. Les programmes sont conçus à l'intention de jeunes femmes de différents âges et milieux; malgré des similarités évidentes, ils comportent tous un thème pédagogique différent. Cette table ronde mettra l'accent sur ce qui fait d'un programme d'été de sciences pour les jeunes femmes une réussite, sur les exigences principales pour un tel programme et la souplesse pour adapter un programme à des objectifs et ressources spécifiques.

Les programmes ont été sélectionnés pour fournir un aperçu sur la diversité de tels programmes. Ils couvrent une vaste région géographique, d'un océan à l'autre, et incluent des jeunes femmes de différents milieux, allant de la petite collectivité rurale à la grande ville. Ils comprennent des programmes résidentiels et de banlieue et des programmes pour les filles de tous les âges, de la septième à la onzième années. Ils sont parrainés par des départements académiques, des centres pour les femmes, des collèges de femmes et des programmes d'enseignement hors école. Ils sont conduits par différentes professionnelles, dont une mathématicienne, une biochimiste, une sociologue, une psychologue et des professeures de mathématiques. Malgré toute cette diversité dans les origines et le développement des programmes, ils comportent quelques similarités. Leur personnel est généralement en grande partie féminin. Les jeunes femmes communiquent avec les facultés universitaires, les chercheuses et chercheurs scientifiques et les étudiantes et étudiants en sciences. Elles sont activement engagées à l'égard des sciences et la recherche est à la base de chaque programme. Les programmes servent tous des populations multiculturelles de jeunes femmes intéressées par les sciences, qui ont la possibilité de rencontrer et de travailler avec d'autres jeunes femmes aux intérêts similaires. Les programmes sont offerts dans les campus, exposant ainsi les étudiantes à un milieu collégial, et font l'objet d'un suivi chaque année scolaire auprès des étudiantes, de leurs professeures et professeurs et de leur famille.

SUMMER SCIENCE & TECHNOLOGY PROGRAMS FOR YOUNG WOMEN

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Dr. Cinda-Sue Davis, University of Michigan,
Mary Ann Evans, Iowa State University,
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Dr. Nancy Cook, University of Washington

Summer science and technology programs for young women at five universities across the United States will be presented. The programs are for young women of different ages and from different environments, and they have different curricular foci, yet there is a core of similarities among them. The focus of this round table will be on what defines a successful summer science program for young women, the core requirements for such a program, and the flexibility to adapt a program to one's specific goals and resources.

The programs were selected to provide an overview of the diversity of such programs. They cover a wide geographical area from the east to the west coast, and include young women from differing environments, ranging from small, rural communities to the inner city. They include both residential and commuter programs, and programs for girls across a wide age range, from seventh through eleventh grades. They are sponsored by different disciplines - academic departments, Women's Centers, Women's Colleges, and outreach programs. They are conducted by women from different disciplines, including a mathematician, a biochemist, a sociologist, a psychologist, and mathematics educators. Yet with such diversity in the origins and development of the programs, there is a core of similarities among these programs. They all have a predominately female staff. The young women interact with university faculty, research scientists, and students in the sciences. They are actively engaged in doing science, and research is a focus of each program. The programs all serve multi-cultural populations of young women interested in science, who have an opportunity to meet and work with other young women with similar interests. The programs are housed on campus, thereby exposing students to a college environment, and there is academic year contact with the students, their teachers and families.

INTERNATIONAL NETWORKING SPRINGING FROM GASAT TO ENCOURAGE EARLY ADOLESCENT GIRLS IN SCIENCE

Kerrie Mullins Gunst and Walter S. Smith

Suite à leur contact initial, lors du colloque international GASAT d'Ann Arbor, au Michigan, en 1987, une équipe d'éducatrices et éducateurs australiens et américains ont adapté le programme COMETS, un programme conçu, à l'origine, pour les États-Unis, à la situation australienne. Suite à une série de réunions en 1988 à Canberra et à Melbourne et à l'obtention de fonds de plusieurs organismes australiens et de l'Université de Kansas, le directeur américain de COMETS s'est joint, au début de 1990, à plus d'une centaine d'éducatrices et éducateurs australiens de Melbourne, Sydney, Perth, Adelaide, Alice Springs et Brisbane, en vue de modifier la version américaine du programme COMETS pour mieux refléter la situation australienne. Une telle initiative exigeait de modifier tant le format des cours pour les écoles australiennes que le contenu de ces cours, afin de refléter des exemples australiens plutôt qu'américains.

Le COMETS australien intègre les sciences et les arts du langage dans une approche pédagogique du langage dans les classes de la 5e à la 9e années en vue d'encourager les jeunes adolescentes à étudier les sciences et à poursuivre une carrière dans ce domaine. COMETS fait appel à plusieurs stratégies pédagogiques : leçons en salle de classe données par des personnes-ressources de la collectivité, renseignements sur diverses femmes ayant fait une contribution majeure dans le domaine des sciences, profils biographiques de la femme contemporaine «de tous les jours» et façon dont cette femme utilise les sciences dans le cadre de son travail, de ses activités scientifiques pratiques et des cours d'arts du langage intégrés. Le projet australien COMETS vient d'être nommé «projet d'importance nationale» (Project of National Significance) par le gouvernement australien.

Pour faire suite au document que nous vous présentons, nous allons discuter avec vous des façons de faire profiter d'autres nations du projet COMETS.

INTERNATIONAL NETWORKING SPRINGING FROM GASAT TO ENCOURAGE EARLY ADOLESCENT GIRLS IN SCIENCE

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Starting with their initial contact at GASAT 4 in Ann Arbor, Michigan, in 1987, a team of Australian and American educators have adapted COMETS, originally developed for use in the United States, to Australia. Following meetings in 1988 in Canberra and Melbourne and obtaining funds from several Australian organisations and the University of Kansas, the American COMETS difector, worked in early 1990 with over a hundred Australian educators in Melbourne, Sydney, Perth, Adelaide, Alice Springs, and Brisbane to modify the American version of COMETS to Australia. Adaptation meant changes both in the form of the lessons to fit the Australian schools and in the content of the lessons to reflect Australian, rather than American examples.

Australian COMETS closely integrates science and language arts in a whole language instructional approach in grades 5-9 to encourage early adolescent girls in science study and toward science careers. COMETS employs several teaching strategies: classroom lessons led by community resource people, information about major female contributors in science, biographical profiles of contemporary "everyday" women and how they use science in their work, hands-on science activities, and integrated language arts lesson. The COMETS Australia Project has just been designated a Project of National Significance by the Australian Government.

Following the formal paper, we would like to discuss with the audience ways to extend this network to bring COMETS to other nations.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

ENCOURAGING BRIGHT AND GIFTED FEMALE ADOLESCENTS IN TECHNOLOGY AND ENTREPRENEURSHIP: THE SHAD VALLEY EXPERIENCE

D' Elizabeth Smyth
Ron Champion

Le programme Shad Valley est un programme d'été à plein temps à l'intention des adolescentes et adolescents intelligents et doués du Centre canadien de technologie créative. Le centre est un organisme national à but non lucratif qui s'engage à créer des liens entre l'industrie et l'éducation, et plus particulièrement dans les domaines de la technologie et de l'entrepreneuriat. Les participantes et participantes à ce programme proviennent de toutes les provinces et des deux territoires et représentent tous les groupes culturels, y compris les Premières nations. En 1992, le programme Shad Valley a reçu un prix national d'excellence en partenariats entreprise - enseignement du Conference Board du Canada.

Le programme Shad Valley comporte un certain nombre d'objectifs, dont :

- permettre aux adolescentes et adolescents d'acquérir une certaine expérience pratique en technologie;
- aider et encourager les adolescentes et adolescents à réaliser leur plein potentiel;
- favoriser leur esprit d'entreprise.

Le programme, offert à un seul endroit en 1980, est désormais offert dans 8 campus universitaires à travers le Canada. Il existe plus de 3 000 «survivantes et survivants du programme Shad» à travers le pays et dans le monde.

Cette présentation nous permettra d'évaluer l'impact du programme Shad Valley sur les jeunes femmes. Dans les dix années d'existence du programme, la participation des femmes a augmenté chaque année à l'échelle nationale, pour atteindre 50 % en 1992. Un chiffre remarquable pour un programme d'été à plein temps mixte. La séance proposée est divisée en deux parties. Après une analyse des données actuelles disponibles sur l'impact du programme sur les jeunes femmes, la séance se transformera en un débat de spécialistes, dont des femmes qui ont participé au programme Shad Valley. Les participantes et participants comprendront :

- un(e) participant(e) d'âge secondaire;
- un(e) diplômé(e);
- une professionnelle «survivante» du programme Shad;
- un(e) instructeur(trice) du programme.

ENCOURAGING BRIGHT AND GIFTED FEMALE ADOLESCENTS IN TECHNOLOGY AND ENTREPRENEURSHIP: THE SHAD VALLEY EXPERIENCE

Dr. Elizabeth Smyth, Ontario Institute for Studies in Education, Ron Champion, Centre for Creative Technology, panelists to be announced

The Shad Valley Program is a summer residential program for bright and gifted adolescents operated by the Canadian Centre for Creative Technology. The Centre is a national non-profit corporation, dedicated to building bridges between industry and education, especially in the areas of technology and entrepreneurship. Participants in the program are drawn from all provinces and the two territories and represent all cultural groups, including First Nations. In 1992, The Shad Valley Program was a National Winner of the Conference Board of Canada's National Awards for Excellence in Business-Education Partnership.

The Shad Valley Program has a number of goals including:

- giving adolescents a hands-on experience of technology;
- helping adolescents come to a full realization of their potential and giving them the encouragement they need to achieve it;
- fostering their entrepeneurial spirit.

From a single site in 1980, the program has grown to include eight sites on university campuses across Canada. There are over 3000 "Shad Survivors" scattered across the country and around the world.

This presentation will explore the impact which the Shad Valley Program has had on young women. Over the ten years of the program's existance, the participation of females in the program has increased annually, on a National basis, to a 1992 figure of 50%. This statistic is remarkable for participation in a coeducational residential summer program. The proposed session will have two parts. Following an analysis of the current research data available on the impact of program on young women, the session will then become a panel discussion with women who have been involved in Shad Valley. Participants will include:

- a recent high school-aged participant
- a graduate student
- a Shad Survivor launched in her career
- an instructor on the program.

GENDER CONSTRUCTION AND SCIENCE TEACHER EDUCATION: MOTELS FOR CHANGE

Andrea Allard, Gaell Hildebrand et autres

Ce symposium présente des modèles de programmes de formation préalable et interne des enseignantes et enseignants tout en permettant à ces dernières et derniers d'évaluer leur propre compréhension des rôles masculins et féminins et d'examiner leurs relations avec les sciences et la technologie dans le programme d'études.

De récentes études suggèrent que le changement recherché en matière d'égalité des sexes est impossible si les enseignantes et enseignants ne réévaluent pas leurs opinions personnelles et professionnelles sur le rôle des sexes. Les enseignantes et enseignant peuvent ensuite explorer les façons dont leur sélection du contenu, de l'approche, des stratégies d'enseignement, des activités d'apprentissage et des pratiques d'évaluation favorisent les comportements traditionnels sexuellement discriminatoires.

La pédagogie féministe tente également de remettre en question les relations de pouvoir traditionnelles inéquitables entre l'adulte et l'enfant entre l'homme et la femme. Différents modes d'organisation dans la salle de classe, incluant les aptitudes à résoudre les conflits et de communication active, permettent aux professeures et professeurs de sciences d'aborder les questions relatives aux sexes et à la relation de pouvoir. La nature des sciences, révélatrice du sexe, et le programme de sciences doivent également subir un changement parallèle.

Dans ce symposium, nous étudierons le rôle des programmes de formation préalable et interne des enseignantes et enseignants dans l'élaboration de modèles efficaces de changement. Nous parlerons aussi brièvement des facteurs favorisant le changement dans ce domaine. Par exemple, un milieu qui soutient la prise de risques et l'accès aux conseils d'expertes et experts sont suggérés comme deux composantes essentielles pour permettre au personnel enseignant de commencer à inclure les questions de sexe dans leurs programmes d'études. Le symposium nous permettra également de reconnaître et de parler des obstacles qui nuisent au changement.

GENDER CONSTRUCTION AND SCIENCE TEACHER EDUCATION: MODELS FOR CHANGE

Andrea Allard, Gaell Hildebrand and others.
University of Melbourne, Australia, and others.

This symposium will present models of pre-service and inservice teacher education programs which enable teachers to explore their own understandings about the construction of gender and to investigate how these interact with the construction of science and technology in the school curriculum.

Recent research suggests that real change in gender equity is not possible until teachers examine their own personal and professional understandings concerning the construction of gender. Teachers can then explore the ways in which their selection of content, approach, teaching strategies, learning activities and assessment practices work to challenge or to endorse traditional, limiting gendered behaviours.

Feminist pedagogy also seeks to challenge the traditional inequitable power relationships between adult and child, male and female. Different modes of classroom organization which include conflict resolution and active communication skills are means by which science teachers can address the dimensions of gender and power. The gendered nature of science itself and the science curriculum also require parallel change.

This symposium will explore the role that teacher pre-service and inservice programs can play in contributing to successful models of change. Factors which facilitate change in this field will be tentatively explored. For example, an environment supportive of risk-taking behaviours and access to expert advice are suggested as two essential components for enabling teachers to begin to address gender issues in education. The symposium will also identify and discuss those barriers which are counterproductive of change.

ADVANCING WOMEN IN UNIVERSITY SCIENCE AND TECHNOLOGY: THE ROLE OF POSTSECONDARY STAKEHOLDERS

Council of Ontario Universities

Ce symposium est un survol des stratégies futures visant à accroître la participation des femmes dans les programmes de sciences et de technologie des universités ontariennes. La présidente du symposium est le D' Sandra Pyke, professeure de psychologie et ancienne doyenne du programme d'études supérieures de l'Université York, qui a également été présidente du COU Committee on the Status of Women et du Ontario Council on Graduate Studies. Parmi les membres du symposium, nous retrouvons des représentantes et représentants du personnel administratif supérieur de l'université; des représentantes et représentants du ministère de l'Éducation et de la Formation ontarien; des doyennes et doyens et des directrices et directreurs d'études des sciences et du génie; des membres d'associations professionnelles; et des employeuses et employeurs de diplômées et diplômés de programmes de sciences et de technologie.

Une présentation d'ouverture décrit brièvement le système universitaire ontarien et la structure des politiques publiques, et donne certains renseignements illustrant les plus récents changements en matière de représentation des femmes. Chaque membre du symposium doit répondre aux questions suivantes :

1. Quelles barrières spécifiques nuisent encore à la participation et à la réussite des femmes dans les programmes de sciences et de technologie au niveau postsecondaire?
2. Quelles stratégies ou politiques visant à éliminer ces barrières et à accroître la participation des femmes ont été les plus efficaces? les moins efficaces?
3. De quelles nouvelles stratégies ou politiques publiques a-t-on désormais besoin?
4. Quel rôle chaque groupe participant devrait-il jouer? Comment peuvent-ils travailler ensemble?
5. Que peut-on faire dans une telle ère de restrictions pour assurer que l'évolution du changement ne soit pas ralentie?

Bien que le symposium mette l'accent sur les universités et la structure des politiques publiques ontariennes, les approches et structures décrites peuvent s'appliquer à d'autres juridictions.

ADVANCING WOMEN IN UNIVERSITY SCIENCE AND TECHNOLOGY: THE ROLE OF POSTSECONDARY STAKEHOLDERS

COUNCIL OF ONTARIO UNIVERSITIES COMMITTEE ON THE STATUS OF WOMEN

This symposium presents perspectives on future strategies for increasing the participation of women in university science and technology programmes in Ontario. The symposium's chair is Dr. Sandra Pyke, Professor of Psychology and former Dean of Graduate Studies, York University, who has also served as Chair of the COU Committee on the Status of Women and Chair of the Ontario Council on Graduate Studies. Symposium members will include representatives of senior university administration; the Ontario Ministry of Education and Training; science/engineering deans and faculty; professional associations and employers of science and technology graduates.

An opening presentation will briefly describe the Ontario university system and the public policy framework, with some data showing changes in the representation of women in recent years. Each member of the symposium will be asked to respond to the following questions:

1. What specific barriers still impede the participation and achievement of women in science and technology programmes at the postsecondary level?
2. What strategies or policies for removing barriers and increasing participation have been most effective? Least effective?
3. What new strategies or policy initiatives are needed?
4. What role should each stakeholder group play? How can they work together?
5. What can be done in an era of restraint to ensure that the momentum for change is not lost?

Although the symposium will focus on the Ontario universities and public policy environment, the approaches and structures described might be transferable to other jurisdictions.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

RESEARCHING, REPRESENTING AND REFORMING GIRLS' SCHOOL EXPERIENCES: AN INTERNATIONAL COMPARISON OF THE DISCOURSE ON GIRLS IN SCIENCE AND TECHNOLOGY EDUCATION

Deb Hayes, Else-Marie Staberg,
Monique Volman and Vicky Webber

Au cours des quinze à vingt dernières années, les questions relatives à l'éducation des filles ont été placées au centre d'un discours en évolution sur l'éducation des sciences et de la technologie. En Australie, aux Pays-Bas, en Suède et aux États-Unis, la recherche a mis l'accent sur la participation des filles dans le domaine des sciences et de la technologie en tentant d'identifier les différences entre les sexes, les raisons des choix de carrière des filles, et de développer des stratégies d'enseignement qui permettraient d'accroître l'intérêt et la participation des filles dans les domaines «non traditionnels».

Bien que ce discours ait permis avec succès de mettre l'accent sur les filles dans le domaine des sciences et de la technologie, les intervenantes au symposium critiqueront les caractéristiques de cette attention d'un point de vue féministe.

Nous espérons démontrer la façon dont les filles ont été incluses au discours sur les sciences et la technologie dans les écoles en comparant et en établissant un contraste entre les questions et méthodologies de recherche choisies, la manière dont les résultats ont été analysés et les stratégies qui ont été proposées dans ces quatre pays.

Chaque intervenante parlera brièvement des développements et des débats actuels au sein de leur pays respectif. Les différences et les similarités dans l'impact de ces débats sur les programmes scolaires seront évaluées. Nous allons également tenter d'identifier ce que nous considérons comme des questions importantes et des directions pour l'avenir.

RESEARCHING, REPRESENTING AND REFORMING GIRLS' SCHOOL EXPERIENCES: AN INTERNATIONAL COMPARISON OF THE DISCOURSE ON GIRLS IN SCIENCE AND TECHNOLOGY EDUCATION

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OVERVIEW

During the past fifteen to twenty years, issues related to girls' education have become the focus of an expanding discourse in science and technology education. In Australia, the Netherlands, Sweden and the USA at least, research has focused on girls participation in science and technology by attempting to delineate sex differences, identify reasons for girls career choices and develop teaching strategies which may increase girls interest and participation in 'non-traditional' subjects.

Although the expansion of this discourse has successfully focused attention on girls in science and technology, symposium contributors will critique the characteristics of this attention from a feminist perspective.

We hope to show how girls have been constructed in the discourse on science and technology education by comparing and contrasting the choice of research questions and methodologies, the manner in which the results have been analysed and the strategies that have been proposed in our four countries.

Each contributor will briefly comment on developments and current debates in her country. The differences and similarities in how these debates have influenced school curricula will be evaluated. We will also attempt to identify what we consider to be important issues and directions for the future.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

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The use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science

Susan M. Brown

Au colloque GASAT 6, j'ai remis un document intitulé «The Use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science». Ce document décrivait un projet de recherche que j'avais conduit à l'University of Western Australia pour examiner l'efficacité des modèles à imiter «professionnels» (c'est-à-dire, les travailleuses scientifiques et les ingénieures). Ce document abordait l'utilisation de ces modèles à imiter dans les programmes d'intervention visant à encourager les filles à s'intéresser à ces matières et à réduire les attitudes stéréotypées à l'égard des femmes dans ces domaines. Ma recherche est terminée. Elle révèle ce qui suit :

i) les modèles à imiter féminins peuvent aider à «briser» les attitudes stéréotypées à l'égard des mathématiques, des sciences et des professions connexes chez les filles et les garçons;
ii) les modèles à imiter influencent le choix de la matière, davantage chez les étudiantes et étudiants plus intelligents et plus sûrs d'eux-mêmes, mais aussi chez les étudiantes et étudiants moyens;
iii) les modèles à imiter semblent aider à confirmer des choix déjà faits;
iv) l'effet de l'imitation de rôle est influencé par d'autres facteurs (par ex., si une étudiante connaissait déjà une travailleuse scientifique ou une ingénieure). Toutefois, on n'a pu recueillir de preuve pour établir que le type d'école avait une influence;
v) tout effet «négatif» des modèles à imiter était minime;
vi) en dépit de l'influence que les modèles à imiter ont et peuvent avoir, les parents demeurent la plus grande influence sur le choix de la matière étudiée des étudiantes et étudiants.

Ainsi, cette étude indique que de tels modèles à imiter peuvent faire plus que de «briser les stéréotypes».

Cette table ronde pourrait aborder les divers types de modèles à imiter et les façons dont nous les avons utilisés dans les expérimentations passées et courantes. Elle pourrait aborder les conclusions d'autres études sur l'efficacité des modèles à imiter et l'expérience des gens qui ont participé à de tels programmes d'intervention; elle pourrait aussi établir le rôle que les modèles à imiter devraient avoir dans de tels programmes à l'avenir et la direction que les futures recherches et pratiques dans ce domaine devraient prendre.

The Use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science

Susan M. Brown
The University of Melbourne
Australia

At GASAT 6, I gave a paper on "The Use of Role Models in Programmes to Increase the Participation of Girls in Maths and Science." This described a research project I had carried out at the University of Western Australia to investigate the effectiveness of "occupational" role models (that is of women scientists and engineers). It looked at the use of these role models in intervention programmes which encouraged girls' participation in these subjects and which aimed to reduce stereotyped attitudes towards women in these fields. This research is now complete and the study has found that:

i) Female role models can help to break down stereotyped attitudes towards mathematics, science and related careers in both boys and girls.

ii) They do influence students' subject choices, more so for the very bright and confident students but also for more average students.

iii) They appear to help to confirm subject choices already made.

iv) The effect of role modelling is influenced by some other factors, such as whether a student already knew a female scientist or engineer but there was not enough evidence on the whole to judge whether a student's school type was an influencing factor.

v) Any "negative" effect of the role models was minimal.

vi) Despite the influence that role models can and do have, parents remain the single greatest influence on a students' subject choices.

Thus this study indicate that such role models can do more than just "breaking down stereotypes."

This round table discussion could look at the various types of role models and the ways they have been used in past and current intervention studies. It could discuss other research findings as to the effectiveness of role models and the experience of people involved in such intervention programmes; consider the place of role models in such programmes in the future and the direction that future research and practice in this field should take.]

THE OLYMPIADES IN MATHEMATICS, PHYSICS, CHEMISTRY, INFORMATICS...

Cecile K.M. Crutzen

Les olympiades en mathématiques, physique, chimie, informatique, etc., organisées avec le soutien de l'Unesco sont sous-représentées par les jeunes filles.

Les questions suivantes seront posées et abordées dans le cadre de cette table ronde :

1. Quelles sont les raisons de la sous-representation des jeunes filles?

2. Devrait-on encourager les jeunes filles à participer à des activités compétitives? Si oui, comment nous y prendre?

3. Comment peut-on altérer les circonstances et les règles des olympiades nationales et internationales pour garantir que plus de pays veilleront à accroître la participation des jeunes filles?

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

THE OLYMPIADES IN MATHEMATICS, PHYSIKS, CHEMISTRY, INFORMATICS...

Cecile K.M. Crutzen, Department of Engineering,
Open University, The Netherlands

The Olympiades in Mathematics, Physiks, Chemistry, Informatics etc. which are organized under the support of UNESCO are underrepresented by girls.

These questions will be posed and discussed at the round table session:

1. What are the reasons for that underrepresentation?
2. Does it make sense to encourage girls to participate in competitive activities? How should it be done?
3. How is it possible to change the circumstances and the rules in the national and international olympiades to guarantee that more countries will let more girls participate?

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

528

EXPANDING OPTIONS TO KINDLE GIRLS' INTERESTS AND ASPIRATIONS IN SCIENCE AND TECHNOLOGY

Groupe-clé «Here Today... Where Tomorrow?»

Cette table ronde est une continuation de l'atelier pratique du colloque GASAT 7 intitulé Becoming Adept and Comfortable with Science and Technology. On encourage les participantes et participants à se baser sur le processus d'apprentissage créatif et relationnel de l'atelier pour aborder des questions générales. Dans le cadre d'une discussion ouverte, les participantes et participants partagent leurs expériences et étudient des façons novatrices d'encourager les filles à explorer les sciences et la technologie par le biais d'activités créatives et artisanales qui remettent en question les pratiques sociales qui sabotent l'enthousiasme des filles.

Parmi les objectifs de cette table ronde, notons :

- tirer des expériences de l'atelier du GASAT 7, Becoming Adept and Comfortable with Science and Technology Curriculum, pour examiner des stratégies visant à accroître les options qui réveillent l'intérêt des filles à l'égard des mathématiques, des sciences et de la technologie;
- visualiser des projets axés sur les participantes et participants et appropriés pour la mise en oeuvre d'un modèle de partenariat communautaire dans les milieux ruraux et isolés ne bénéficiant que de maigres ressources conventionnelles; et
- se servir de la diversité culturelle de différentes collectivités comme d'une ressource clé pour développer des programmes d'intervention dans l'enseignement ordinaire.

EXPANDING OPTIONS TO KINDLE GIRLS' INTERESTS AND ASPIRATIONS IN SCIENCE AND TECHNOLOGY

"Here Today...Where Tomorrow?" Resource Team

This Roundtable is a continuation of the GASAT 7 hands-on workshop Becoming Adept and Comfortable with Science and Technology. Participants are encouraged to draw on the creative, relational learning process of the workshop when raising issues within the larger picture. In an open discussion participants will share experiences and consider innovative ways to encourage girls to explore science and technology through creative, craft-based activities which challenge social practices that inhibit girls' enthusiasm.

Objectives of the roundtable process include:

- drawing on experiences of the GASAT 7 workshop, Becoming Adept and Comfortable with Science and Technology Curriculum, to consider strategies to expand options which kindle girls' interests and aspirations in math, science and technology;
- envisioning projects which are participant-driven and appropriate for community-based partnership model implementation in rural and isolated settings with limited conventional resources; and,
- tapping cultural diversity as a key resource in different communities to develop intervention programs at the margins of mainstream education.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

WOMEN IN SCIENCE: A MULTIMEDIA DATABASE

Lois McLean and Richard Tessman

Une base de données interactive, multimédia, sur disque optique compact, faisant la description de travailleuses scientifiques et de leur travail sera présentée. McLean Media met au point un programme logiciel sur les femmes dans les sciences, avec l'aide financière de la National Science Foundation, par le biais du Small Business Innovation Research Program (SBIR). Faisant appel à la technologie des ordinateurs pour le son, les photos, les illustrations, les animations et le texte, le disque permettra aux étudiantes et étudiants d'interviewer des travailleuses scientifiques, de feuilleter leurs albums de photos personnels, de tester des activités du travail des travailleuses scientifiques, de rendre visite à ces travailleuses au travail et d'obtenir des renseignements sur des travailleuses scientifiques particulières et sur leur carrière. En 1991, à l'aide de la HyperCard, les auteurs ont créé un prototype de six travailleuses scientifiques et l'ont évalué avec des étudiantes et étudiants du palier élémentaire. Ce prototype de la Phase I prouvait qu'il était techniquement possible de créer un disque optique compact avec des travailleuses scientifiques modèles à imiter, et l'évaluation initiale indiquait que le sujet et le format intéressent énormément le groupe cible d'étudiantes et étudiants du niveau intermédiaire. On prévoit la production et l'essai d'un disque optique compact pour la Phase II dès 1993-1994. Les animatrices et animateurs présenteront la plus récente version du programme, aborderont les questions de conception et de mise au point et nous feront part des résultats initiaux de l'évaluation de l'utilisation de moyens techniques pour présenter des modèles à imiter.

WOMEN IN SCIENCE: A MULTIMEDIA DATABASE

Lois McLean, Ed.D. & Richard Tessman, McLean Media,
Mill Valley, California

An interactive, multimedia CD-ROM database featuring women scientists and their work will be demonstrated. McLean Media is developing a software program about women in science, with funding from the National Science Foundation through the Small Business Innovation Research Program (SBIR). Using computer technology to provide audio, photo, illustrations, animations and text, the completed disc will allows students to interview scientists, browse through their personal photo albums, try activities based on the scientists' work, visit the scientists at work and locate information on specific scientists and careers. In 1991, using HyperCard, the authors created a prototype featuring six scientists and evaluated it with elementary students. This Phase I prototype demonstrated that producing a CD-ROM featurillg women scientists as role models is technically feasible, and initial evaluation indicated that the topic and format have strong appeal for the target audience of intermediate and middle-school students.
Further production and pilot testing of a CD-ROM disc are planned for Phase II in 1993-94. The presenters will show the latest version of the program, discuss design and development issues and share initial evaluation results in using technology as a tool to introduce role models.

DO INTERVENTION STRATEGIES MAKE A DIFFERENCE?

Elinor Nicoll and Nan Armour

Au cours des dernières années, un certain nombre de stratégies d'intervention ont été mises en oeuvre pour, avant tout, encourager les filles et les adolescentes à poursuivre leurs études dans le domaine des sciences et de la technologie et à envisager une carrière dans ces secteurs. Les stratégies d'intervention mises en oeuvre ont-elles permis d'atteindre cet objectif? Les stratégies d'évaluation nous ont-elles permis d'établir avec certitude que l'objectif avait été atteint? Les effets à court terme sont souvent évidents, mais qu'en est-il des effets à plus long terme? Que pourrait-on considérer comme une preuve acceptable? Les filles continuent-elles d'étudier les sciences et la technologie? Qu'en est-il de leurs choix professionnels? Est-il bien réaliste de tenter de quantifier les effets des stratégies d'intervention? Si non, comment pouvons-nous répondre à la question suivante : «Les stratégies d'intervention peuvent-elles faire une différence?».

Les participantes et participants à cette table ronde décrivent leurs expériences dans le cadre d'un stage d'été visant à accroître la participation des adolescentes dans les programmes de sciences, de mathématiques et de technologie des écoles secondaires et des établissements d'enseignement supérieur, et à accroître leur nombre dans les professions de ces secteurs. On met l'accent sur les approches qui permettent d'évaluer les effets à court et à long termes du stage sur les choix d'études et de carrière futurs. Les participantes et participants de la table ronde sont invités à nous parler de leurs tentatives d'évaluation des stratégies d'intervention - leurs réalisations, les difficultés rencontrées, ce qu'elles et ils ont appris, et leurs conseils. L'objectif est de tirer parti de l'expérience collective de toutes les participantes et de tous les participants afin de mettre en oeuvre des stratégies d'évaluation viables. Si nous pouvons efficacement évaluer les effets des stratégies d'intervention, nous pouvons alors apprendre de nos erreurs et constamment améliorer les nouvelles stratégies d'intervention.

DO INTERVENTION STRATEGIES MAKE A DIFFERENCE?

Elinor Nicoll, Supervisor Science and Technology Education, Halifax
Nan Armour, Education Consultant, Armour and Associates

Over the past several years, a number of intervention strategies have been implemented with the primary goal of encouraging girls and young women to continue to study science and technology and to consider careers in these areas. Do these interventions meet this goal? Have assessment strategies been developed to adequately determine if the goal has been met? Immediate impacts are often obvious, but what about the more difficult long term effects? What would be acceptable evidence? Do girls continue to study science and technology? What about their career choices? Is it realistic to attempt to quantify the impacts of interventions? If not, then how do we answer the question 'Do intervention strategies make a difference?'

The presiders at this Round Table will describe their experiences in a Summer Institute designed to increase the number of young women choosing to study science, math and technology in high school and post-secondary institutions, and to increase their participation in related careers. The focus will be on approaches to assess the short and long term impacts of the Institute on future study and career choices. Participants at the Round Table will be invited to share their attempts to assess intervention strategies - their successes, their difficulties, what they've learned, and their advice to others. The objective is to learn from the collective experiences of all the participants in the search for valid assessment strategies. If we can effectively assess the impacts of interventions, we can learn to develop better intervention strategies.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

GIRLS, SCIENCE, INFORMATION, TECHNOLOGY AND CREATIVITY

Annette Sharp

En installant quelques ordinateurs dans la bibliothèque de l'école secondaire Westlake pour filles, on l'a transformée en un centre d'apprentissage multimédias pour les élèves. Une telle initiative a été calquée dans les programmes d'études, de façon à fournir un plus grand nombre d'ordinateurs pour les activités d'apprentissage en classe. Le personnel enseignant, composé en grande partie de diplômées universitaires, reçoit également une formation pour utiliser à meilleur escient les ordinateurs et les présentations multimédias dans la préparation des leçons.

Des groupes d'étudiantes et étudiants reçoivent une formation sur les présentations multimédias. Cette formation leur donne la possibilité d'utiliser les aptitudes acquises dans tous les domaines du programme d'études, par ex., les aptitudes en graphisme, musique et écriture, pour présenter un rapport de sciences. Les cartes HyperCard et QuickTime des ordinateurs Macintosh sont utilisées pour créer des bases de données, à partir des recherches et écrits des étudiantes et étudiants de l'école. Les élèves des programmes de sciences apprennent à utiliser les ordinateurs et le centre de présentations multimédias pour présenter des rapports pratiques, analyser des données, pour la recherche et la modélisation, et apprennent comment utiliser les dispositifs d'interface avec l'ordinateur pour la saisie des données.

On s'attend à ce que les étudiantes et étudiants de tous les niveaux apprécient davantage et obtiennent de meilleurs résultats grâce à ces possibilités. En fournissant la formation dans ces domaines au sein de l'école, on espère que les filles gagneront confiance en leur aptitude à utiliser la technologie, à développer leurs compétences en recherche et à reconnaître que la créativité et la capacité de communiquer sont importantes dans le domaine des sciences. Il y aura un rapport de recherche qui fera état des programmes de formation, des réactions et de la participation des étudiantes et étudiants et du personnel, ainsi que de toute influence de ce développement sur les choix de carrière.

GIRLS, SCIENCE, INFORMATION TECHNOLOGY AND CREATIVITY.

Annette Sharp, Westlake Girls High School, Auckland,
New Zealand

A suite of computer has been installed in the Westlake Girls High School library as a multi media learning centre for students. A parallel development is taking place in curriculum areas to provide more computers for classroom learning activities . Teaching staff, predominantly female university graduates, are also being given training to enable them to make greater use of computer facilities and multimedia presentations for lesson preparation .

Groups of students are being trained in multi media presentations. This provides them with opportunities to use skills gained in all curriculum areas, e.g. to use their graphics, music and writing skills to present a report for science. HyperCard and QuickTime on the Macintosh computers are being used to create databases, from the research and writing completed by students within the school. Science students are developing the skills to use the computers and the multimedia centre to present practical reports, to analyse data, for research and computer modelling and in the use of computer interfaces for data capture.

It is hoped that students of all abilities will gain more enjoyment and positive learning outcomes from these opportunities. By providing training in the use of these facilities within the school we hope that the girls will gain confidence in their ability to use the technology, develop their research skills, and recognise that their creativity and communication skills are important in science.

There will be a report on the training programmes, the response and participation of students and staff, and any influence this development is having on career choice.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

RESEARCH IN THE AREA OF GIRLS' PARTICIPATION IN THE SCIENCES

Jane N. Mulemwa

En tant que formatrice d'enseignantes et enseignants à l'université, je m'intéresse aux recherches effectuées en matière de participation des jeunes filles dans le domaine d'études des sciences au niveau de l'école secondaire, où l'on choisit de poursuivre ou non des études ou une carrière scientifique. J'élabore actuellement un plan de recherche intitulé «A Comprehensive Study of what the Girls'/Women themselves see as the strategies for Retaining Girls in Science-Based courses at Post Primary Level in Uganda».

Dans le cadre de cette table ronde, nous parlerons, en particulier, des recherches et méthodologies de recherches actuelles relatives à l'apprentissage des jeunes filles et à leur participation soutenue dans les domaines d'études et carrières en sciences, en technologie et en mathématiques.

RESEARCH IN THE AREA OF GIRLS' PARTICIPATION IN THE SCIENCES

Jane N. Mulemwa (Ph. D.), Makerere University, Kampala, UGANDA

As a science teacher-educator at university, I am interested in research in the area of girls' participation in the sciences at the secondary school level, since this is the level at which the choice to pursue science-based jobs and careers is made. I am writing a research proposal on, "A Comprehensive Study of what the Girls/Women themselves see as the strategies for Retaining Girls in Science-Based courses at the Post Primary Level in Uganda".

This round-table discussion will focus on the current research and research methodologies with regards to how girls best learn and sustain their participation in the science, technology and mathematics fields of study and careers.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

THE ROLE OF GOVERNMENT IN PROMOTING EDUCATIONAL EQUITY FOR GIRLS IN SCIENCE

Shirley Avril

En Colombie-Britannique, au Canada, le Gender Equity Program (programme d'égalité des sexes) est étroitement lié au phénomène de transformation de l'enseignement depuis 1991. Au départ, ce programme avait pour objectif d'accroître le nombre de femmes dans les rôles de leader dans l'ensemble du système d'éducation et de fournir le soutien nécessaire aux jeunes filles qui décidaient de se lancer dans des carrières non traditionnelles. L'intervention du ministère dans le développement du programme d'études était la suivante : recommander des ressources d'apprentissage et du soutien pour les organismes d'enseignement mettant en oeuvre le changement pour les jeunes filles et les femmes au sein du système.

Depuis 1991, le Gender Equity Program est devenu plus proactif et est de plus en plus étroitement lié aux programmes du ministère. L'initiative de subventions aux projets dans l'ensemble du système d'éducation fait partie intégrante du programme. Parmi les projets financés, qui ont un rapport avec les sciences, notons Science Venture, un camp de sciences de la faculté de génie de l'Université de Victoria, Ms. Infinity, des congrès scientifiques pour les jeunes filles de 10 à 14 ans, la mise sur pied d'un programme d'études scientifiques adapté aux besoins des jeunes filles et des visites dans les écoles de travailleuses scientifiques pratiquantes.

En outre, le ministère a conçu un atelier à l'intention du personnel enseignant des paliers primaire et intermédiaire sur les stratégies pédagogiques non sexistes dans le domaine des sciences, et a collaboré avec le ministère des Transports et des Autoroutes pour développer un programme visant à encourager les jeunes filles à se lancer dans des carrières en technologie des transports.

Une étude a récemment été publiée : Gender Issues in Student Choices in Mathematics and Science Assessment. Cette étude guide les modifications apportées au programme d'études, aux ressources et aux pratiques en salle de classe, ainsi que les constants travaux de recherche.

Cette table ronde tentera d'aborder la question du rôle du gouvernement dans l'enseignement.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

The Role of Government in Promoting Educational Equity for Girls in Science

Shirley Avril
Coordinator, Gender Equity and Women's Programs
British Columbia Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights

In British Columbia, Canada, the Gender Equity Program has been a component of educational change since 1991. Goals at the beginning of the program were to increase the number of women in leadership roles throughout the education system and to provide support for girls making non-traditional career choices. A role for the Ministry was identified in curriculum development, recommendation of learning resources and support for educational organizations effecting change for girls and women in the system.

Since 1991, the Gender Equity Program has evolved to be more pro-active and more integrated into all Ministry programs. A substantial portion of the program is the grant initiative which supports projects throughout the education system. Funded projects related to science include Science Venture, a science camp at the Faculty of Engineering, University of Victoria, Ms. Infinity, science conferences for girls ages 10-14, development of girl-friendly science curriculum, and school visits from practicing women scientists.

In addition, the Ministry has designed and delivers a workshop for teachers of Primary and Intermediate Program in non-sexist classroom strategies for teaching science and has worked with the Ministry of Transportation and Highways to develop a program that encourages girls to select careers in transportation technology.

Recently published is a study, Gender Issues in Student Choices in Mathematics and Science Assessment. This study provides direction for changes in curricula, resources and classroom practice as well as continued research.

This round table will be a "show and tell" to stimulate discussion of best practice for government in its role in educational leadership.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

WOMEN IN SCIENCE IN AFRICA: THE TWENTY-FIRST CENTURY

Stella Williams

Il est désormais essentiel de partager les idées et les renseignements sur la méthodologie de l'enseignement des sciences dans la région.

Il existe de graves problèmes dans l'orientation professionnelle des étudiantes des écoles de nombreux pays. Nous manquons de conseillères et conseillers professionnels qualifiés dans le système d'éducation de la région. La GASAT sert de tribune d'échange d'information sur les études qui ont été conduites et les méthodes utilisées dans différents pays pour sensibiliser les parents, les preneuses et preneurs de décisions et l'ensemble du public au besoin d'encourager tout le monde à participer à l'enseignement des sciences pour les filles et les garçons.

Le Nigéria a mis sur pied le programme de sensibilisation «JETS AND WOMEN EDUCATION»; au Botswana, on a recours au Science Technology Roadshow pour sensibiliser les gens. Des déléguées et délégués de la région se réuniront dans le cadre d'une table ronde pour partager quelques renseignements sur la situation de leur pays respectif. D'autres seront encouragés à partager leurs propres expériences, pertinentes aux sujets abordés dans le cadre des discussions.

On espère que les déléguées et délégués seront en mesure de former un réseau dans le domaine d'intérêt pour effectuer un suivi de ces discussions.

WOMEN IN SCIENCE IN AFRICA: THE TWENTY-FIRST CENTURY

Stella Williams, Ph.D., Obafemi Awolowo University, Nigeria

There is now a need for sharing of ideas and information on the methodology of science education in the region.

There are serious inadequacies in the career orientation of students in the schools in many countries in the region. There are not enough trained persons to serve as career guidance officers in the educational system in the region. GASAT will present a forum for exchange or information on the research that has been carried out and the methods used in different countries to make parents, policy makers, and the general population aware of the need to encourage everyone to get involved in the education of boys and girls in the field of science.

Awareness was created in Nigeria with 'JETS' and 'WOMEN EDUCATION' programs; in Botswana the Science Technology Roadshow is being used to create awareness. Delegates from the region will come together at a roundtable forum and share ideas of what is happening in their countries. Other delegates will be encouraged to share information from their countries relevant to what they have heard from participants at the forum.

It is hoped that delegates will be able to form a network in the area of interest as a follow up of the ideas presented at the forum.

MATH COMPETITIONS: ARE THEY UNFAIR TO WOMEN?

Ron Lancaster et Shelly Beauchamp

Les jeunes femmes sont fortement sous-représentées dans les premières places des concours de mathématiques. Par exemple, dans le concours de mathématiques canadien de 1992 (Canadian Mathematics Competition) (pour les étudiantes et étudiants de 12e année), 86 des 97 meilleurs élèves étaient des hommes.

Les concours de mathématiques permettent de rehausser le profil des mathématiques et d'impliquer les enseignantes et enseignants et les étudiantes et étudiants dans des activités de mathématiques à l'extérieur de la salle de classe. Toutefois, ils comportent certains effets nuisibles pour les femmes. Ces concours mettent l'accent sur l'aspect compétitif des mathématiques et sont moins intéressants pour les jeunes femmes que pour les hommes. Les supposés médiocres résultats des jeunes femmes dans de tels tests renforcent la perception des gens de la prétendue supériorité des hommes en mathématiques; en fait, le Globe & Mail, dans son article relatif au concours (30 mai 1992), établit un lien entre être un «excellent élève en mathématiques» et obtenir d'excellents résultats à l'examen. De plus, étant donné que certaines bourses d'études universitaires sont fondées sur les résultats de ce concours, les jeunes femmes peuvent se voir refuser des bourses d'études auxquelles elles auraient normalement eu droit sur la base de leur bulletin scolaire ou d'autres critères.

Un des problèmes du concours de mathématiques canadien de l'Université de Waterloo, et probablement celui d'autres concours de mathématiques, est que la composition des collectivités qui conçoivent et notent le concours a été et continue d'être fortement masculine. De plus, les problèmes sont souvent ennuyeux et loin d'être ingénieux. Enfin, il y a pénurie d'activités d'enrichissement de rechange.

Cette table ronde sera composée d'éducatrices et éducateurs des deux côtés de la question. La discussion mettra l'accent sur les pours et les contres des concours de mathématiques et sur les façons de les rendre plus attrayants pour les jeunes femmes. Nous parlerons également des solutions de rechange possibles aux concours de mathématiques.

MATH COMPETITIONS: ARE THEY UNFAIR TO WOMEN?

Ron Lancaster and Shelly Beauchamp

Young women are grossly underrepresented among the top scorers in mathematics competitions. For example, in the 1992 Canadian Mathematics Competition (for grade 12 students) 86 of the 97 top scoring students were male.

Mathematics competitions are an effective way to raise the profile of mathematics and to involve teachers and students in mathematical activities outside the classroom. However, they have a number of detrimental effects on women. Competitions emphasize the competitive aspects of math and are of less interest to young women than men. The allegedly poor performance of young women in such tests reinforces the public perception of male superiority in math; in fact the Globe and Mail newspaper in its report on the competition results (May 30, 1992) equates being a "top mathematical student" with being a top scorer on the exam. Also, because some university scholarships are based on competition results, young women may be denied scholarships to which they are otherwise entitled on the basis of school marks or other criteria.

One of the problems with the University of Waterloo's Canadian Mathematics Competition and probably other math competitions as well, is that the composition of the committees that design and mark the contest has been and continues to be overwhelmingly male. Also, the types of problems are often boring and unimaginative. Finally, there is a dearth of alternative enrichment activities.

This roundtable discussion will feature educators on both sides of the issue. The discussion will focus on the pros and cons of mathematics contests and on ways in which they could be made more engaging for young women. We will also discuss possible alternatives to mathematics contests.

PROMOTING SCIENTIFIC CAREERS FOR WOMEN IN A DEFENSE RESEARCH ESTABLISHMENT

Josée Morin

Au Centre de recherches pour la défense Valcartier (CRDV), les travailleuses scientifiques et les techniciennes représentent environ 8 % de la population scientifique et aucune femme n'est présente dans le domaine de l'organisation scientifique du travail. Le CRDV se heurte à deux obstacles pour recruter les femmes : le faible nombre de femmes qui étudient les sciences dans les universités et le fait que la défense n'est pas un domaine qui habituellement attire les femmes.

Le CRDV a tenté de mettre sur pied différentes initiatives visant à accroître le nombre de femmes dans les postes scientifiques et techniques et à sensibiliser le personnel de gestion au problème de la faible représentation des femmes. Parmi les initiatives majeures, notons la publication d'une brochure sur les femmes dans le domaine des sciences au CRDV, envoyée aux universités canadiennes, la présentation de conférences sur les carrières par des travailleuses scientifiques dans les écoles secondaires et les CÉGEPS et une table ronde sur les femmes dans les professions scientifiques à l'intention des femmes et du personnel de gestion.

Suite à ces initiatives, on s'est heurté aux réactions négatives de nombreux collègues masculins, et plus particulièrement dans les divisions scientifiques où les femmes semblent en plus grand nombre et où les travailleurs scientifiques ne savent comment les aborder. De plus, ces efforts ont été déployés sur une base ad hoc par des individus intéressés. Il est désormais nécessaire de déployer des efforts structurés dans ce domaine. D'autres initiatives devraient être mises sur pied pour poursuivre l'objectif d'une représentation adéquate. Le mentorat a été envisagé, mais le manque de connaissances sur la façon de mettre un tel programme sur pied a découragé tout le monde. Les travailleuses scientifiques ne savent pas vraiment comment mettre sur pied un plan articulé pour accroître le recrutement des femmes, ou si un tel plan est vraiment souhaitable. Des solutions sur la façon de faire face à ces réactions négatives et sur la façon de poursuivre nos objectifs pourraient être développées par le biais d'échanges avec d'autres entreprises qui sont confrontées à des problèmes semblables et par le biais des expériences partagées dans le cadre du colloque international GASAT.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

PROMOTING SCIENTIFIC CAREERS FOR WOMEN IN A DEFENSE RESEARCH ESTABLISHEMENT

Josée Morin
Defense Research Establishment, Valcartier

At Defense Research Establishment, Valcartier (DREV) women scientists and technicians represent around 8% of the scientific population and no women are present in scientific management. DREV has two barriers to overcome when trying to recruit women: the low number of women studying sciences in universities and the fact that defense is not an area traditionally appealing to women.

DREV has tried to put together different initiatives to increase the number of women recruited in scientific or technical positions and to raise the awareness of management to the problems of low female representation. The most important initiatives were the publication of a brochure on women in science at DREV to be sent to Canadian universities, the presentation of conferences on their careers by women scientists to students in secondary school and CEGEP and a round table on women in scientific careers that was held for women and management.

Following these initiatives, a lot of negative reactions arose from male colleagues, especially in the scientific divisions were women appear in larger numbers, and scientists did not know how to deal with them. Also, these efforts were undertaken on an had hoc basis by individuals that believed in the subject. There is now a need for a structured effort in this area. Other initiatives should be undertaken to pursue the goal of adequate representation. Mentoring has been considered, but the lack of knowledge on how to start such a program has discouraged the participants. Women scientist do not really know how to go about putting together an articulated plan for increasing women recruitement, or if such a plan is desirable. Solutions on how to answer negative reactions and how to pursue our goals could be developed through exchanges with other companies that face similar problems and through the experiences shared at the GASAT conference.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque International GASAT 7, Canada, 1993

«JOB-PROFILE»: NEW WAYS OF UPGRADING WOMEN WORKERS AND SERVICING COMPANIES. OUTCOME: BETTER JOBS, BETTER PRODUCTS, BETTER ENVIRONMENT

Lillebit Nordhus and Benthe Stig

Pour que les différentes entreprises s'efforcent d'assurer des chances égales à toutes les femmes, il faut à tout prix leur offrir ce dont elles ont besoin. En ce moment, elles ont besoin de :

- travailleuses et travailleurs qui sont en mesure d'accepter de travailler en ayant recours à de nouvelles techniques;
- travailleuses et travailleurs qui sont capables d'assurer la qualité de l'ensemble du processus.

Contrôle de la qualité et technologies novatrices sont les mots clés de la production des temps modernes. Par ailleurs, les petites et moyennes entreprises n'ont pas l'expérience nécessaire pour :

- recruter du personnel;
- élaborer les profils d'emploi et les profils de qualifications nécessaires pour mettre sur pied des programmes de formation internes adéquats qui permettraient de faire face aux changements de l'organisation du travail.

C'est une occasion unique pour, dans notre cas, les autorités du marché de l'emploi, de développer un service dont ont besoin les entreprises et, en même temps, de créer des débouchés pour les femmes dans les domaines industriels dominés de façon traditionnelle par les hommes. Nous avons mis au point une série de méthodes à cet égard; des méthodes qui nous permettraient de définir les besoins de l'entreprise, ainsi que les qualifications jusqu'ici négligées de ses travailleuses et travailleurs; des méthodes de formation des femmes employées et non employées à des postes qualifiés; la formation des formatrices et formateurs; et la prise de conscience accrue des chefs d'ateliers. Ces activités conduisent à de meilleurs emplois pour les femmes et à une satisfaction professionnelle accrue.

Lillebit Nordhus a, en sa qualité de directrice du programme «Future Jobs for Women», mis au point des méthodes qui permettent de combiner la formation professionnelle et la formation scolaire générale à des séances de formation sur la confiance en soi, et à des séances parallèles de formation des formateurs et des chefs d'ateliers. Benthe Stig gère, pour le Nordic Council of Ministers, un programme des régions nordiques intitulé «Job-Profile», qui prendra fin en septembre 1993.

"JOB-PROFILE": NEW WAYS OF UPGRADING WOMEN WORKERS AND SERVICING COMPANIES. OUTCOME: BETTER JOBS, BETTER PRODUCTS, BETTER ENVIRONMENT

Lillebit Nordhus, Norwegian Labour Market Authority
Benthe Stig, Danish Labour Market Authority

If you want companies to actively work for women's equal opportunities, you have to offer them something they need.
At present they need

- workers who are able to deal with new technologies
- workers who are capable of assuring quality at all parts of the process.

Quality control and innovative technologies are key words in modern production. At the same time small and medium-size companies do not have the expertise needed for

- recruiting staff
- developing job profiles and qualifications profiles necessary for adequate in-service training schemes to fulfil the changes of work organisation.

This is an interesting chance for - in our case - labour market authorities to develop a service of which companies are in need, and at the same time create openings for women in industral fields traditionally dominated by men.
We have developed a series of methods in this field; methods for exposing the needs of the company, as well as the hitherto neglected qualifications of its workers; methods for training employed and unemployed women for qualified jobs; training of trainers; awareness raising training of foremen and shop leaders. The activities lead to better jobs for women and to higher job satisfaction.

Lillebit Nordhus has as program manager of "Future Jobs for Women" developed methods for combining vocational training and general education with self-confidence training, with parallel training of trainers and shop leaders.
Benthe Stig is for the Nordic Council of Ministers managing a threee years' cross-Nordic program "Job-Profile", to end September 1993.

GENDER STUDIES IN THIRD WORLD COUNTRIES - WHO BENEFITS?

Mona Dahms

La question des femmes dans le développement est à l'ordre du jour de la plupart des organismes d'aide au développement des pays du tiers-monde, et l'est d'ailleurs depuis la Décennie des Nations Unies pour la femme, qui s'est terminée en 1985. Ceci parce que l'on a pris conscience du fait que le principal objectif de la collaboration au développement, soit d'améliorer le niveau de vie des populations des pays du tiers-monde, ne peut être atteint sans la participation des femmes.

Dans le cadre de cette table ronde, on décrira une étude de la condition féminine conduite par la Swedish International Development Authority (SIDA), à Dar es Salaam, en Tanzanie. L'étude de la condition féminine a été conduite en Tanzanie et en Zambie au sein d'une importante compagnie de chemin de fer. Cette étude avait pour principal but, selon les organisatrices et organisateurs du GASAT, d'élaborer des politiques visant à augmenter le nombre d'employées au sein de la société. La présentation inclut les objectifs, la méthodologie et les limitations, les principales conclusions, les recommandations et quelques brèves observations sur les stratégies de mise en oeuvre. Les conclusions sont - on n'en sera pas surpris - que très peu de femmes travaillent au sein des compagnies de chemin de fer et que la majorité d'entre elles occupent des postes traditionnellement féminins. Le principal obstacle à l'emploi des femmes dans des postes techniques au sein de la société est le manque de qualifications et de formation scolaire adéquate. La plus importante question relative à l'étude de la condition féminine est de savoir quelles recommandations parmi celles proposées peuvent de façon réaliste être mises en oeuvre.

Plus important encore est la pertinence de telles études de la condition féminine par rapport aux questions des femmes dans le développement dans les pays du tiers-monde. On en parle dans la deuxième partie du document. On conclut le document par une série de questions - qui, nous l'espérons, encourageront à la réflexion et permettront de lancer une intéressante discussion, particulièrement avec les femmes des pays du tiers-monde, lors du colloque international GASAT 7, au Canada, à l'été de 1993.

GENDER STUDIES IN THIRD WORLD COUNTRIES - WHO BENEFITS?

Mona Dahms, University of Aalborg, Denmark.

Women in Development (WID) issues are on the agenda in most development aid organizations operating in Third World countries, and have been since the United Nation's Decade for Women, that ended in 1985. The obvious reason for this is the recognition that the main aims of development cooperation: to improve the standards of living of the populations in Third World countries cannot be attained without the full involvement of women in the development process.

In this contribution to a round-table discussion is described a gender study, initiated by Swedish International Development Authority (SIDA) in Dar es Salaam, Tanzania. The gender study was conducted in Tanzania and Zambia within a large railway corporation. The main aim of the study, seen from a GASAT perspective, was to formulate policies for increased female employment within the corporation. The presentation includes aims and objectives, methodology and limitations, major findings, recommendations and a short note on implementation strategies. The findings are - not surprisingly - that very few women are working within the railway corporation, and the majority of them are working in stereotyped, female dominated jobs. The main barrier to female employment in technical jobs within the corporation is the lack of suitable qualified women with the proper educational background. The most important question for discussion in connection with the gender study itself is which of the given recommendations can realistically be implemented.

More important to me is a discussion of the relevance of such gender studies to WID issues, as well as the relevance of GASAT issues to WID issues in Third World countries. This discussion is raised in the second part of the paper and concluded in a series of questions - hopefully food for thought and basis for a good discussion, particularly with Third World women, at GASAT 7 in Canada, Summer 1993.

SASKATCHEWAN WOMEN IN ENGINEERING – GROWING STRONG

Tami Wall, P.Eng. and Debra Anderson, P.Eng.

La Saskatchewan compte moins d'un million d'habitants disséminés sur une surface géographique relativement importante. Depuis les années 1940, plus de 200 femmes ont obtenu un diplôme d'ingénieure à l'Université de la Saskatchewan et à l'Université de Regina. En 1991, parmi les 3 000 ingénieures et ingénieurs recrutés, seulement 60 étaient inscrites auprès de l'Association of Professional Engineers of Saskatchewan. Toutefois, un grand nombre de femmes n'ont jamais trouvé d'emploi dans le domaine du génie ou ont abandonné leur carrière peu après l'avoir entreprise. En 1992, le Comité des ingénieures a conduit deux sondages visant à établir les problèmes et les besoins. Le Comité des ingénieures a ensuite mis sur pied certains programmes visant à encourager un plus grand nombre de femmes à s'intéresser au génie.

Le premier sondage traitait de la raison pour laquelle les femmes abandonnent les professions de génie. Le sondage a été envoyé aux diplômées d'un programme de génie qui n'avaient jamais trouvé d'emploi dans ce domaine ou qui l'avaient quitté peu de temps après. Le deuxième sondage abordait les besoins des femmes dans le domaine du génie. Ce sondage a été envoyé aux femmes qui sont actuellement inscrites dans la profession.

Dans la population active de la Saskatchewan, les femmes ingénieures font face à :
•une pénurie de mentors ou homologues féminines, une pénurie de réseaux et de femmes ingénieures;

- un nombre étonnant de partis pris contre les femmes; et
- des employeurs qui n'ont élaboré aucune politique pour les aider à équilibrer leurs responsabilités familiales et professionnelles.

Ce sont les principaux facteurs pour lesquels les femmes abandonnent le génie et les principaux besoins des femmes qui sont encore dans la profession. On a insisté sur le fait que leurs collègues masculins devraient recevoir une formation en matière d'équité. Les cours de formation professionnelle en génie ont également été considérés comme un important besoin.

Les résultats de ces deux sondages ont conduit le Comité des ingénieures à mettre sur pied un programme de mentorat, des séminaires de réseautage trimestriels et des projets visant à inciter les femmes à se lancer dans une carrière de génie. Le Comité des ingénieures étudie des ateliers sur l'équité, des cours de mise à jour et les options de partage d'emploi et de congés parentaux offertes aux femmes.

Le Comité des ingénieures tient à profiter de nos conclusions et à en apprendre plus sur les programmes mis sur pied dans d'autres provinces et dans d'autres pays, et plus particulièrement les provinces et les pays peu peuplés.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

SASKATCHEWAN WOMEN IN ENGINEERING — GROWING STRONG

Tami Wall, P.Eng., Secretary and Debra Anderson, P.Eng., Vice-Chair
Women in Engineering Committee, Association of Professional Engineers of Saskatchewan
2255 Thirteenth Avenue, Regina, Saskatchewan Canada S4P 0V6

ABSTRACT

Saskatchewan has a small population base with less than one million residents spread over a large geographic area. Since the 1940's, over 200 women have graduated from engineering programs at the University of Saskatchewan and University of Regina. In 1991, only 60 out of 3000 engineers were women registered with the Association of Professional Engineers of Saskatchewan. Some women have left the province following their careers. However, many women have never found an engineering career or have left their career after a short time. In 1992, the Women in Engineering (WE) Committee conducted two surveys to determine the problems and the needs. WE then developed programs to encourage the number of women in engineering to grow stronger.

The first survey addressed why women leave engineering. This survey was sent to women who had graduated from engineering but had never found an engineering career or left after a short time. The second survey addressed the needs of women in engineering. This survey was sent to women who are currently registered in the profession.

In the Saskatchewan workplace, women engineers find:

- few female mentors or counterparts, lack of networking and lack of women engineers;
- too many biases against women; and
- employers don't have policies to allow them to balance family and career.

These are the primary factors that contribute to women leaving engineering and are also the needs of those women currently working in the profession. There was strong support for the male colleagues to be educated in the area of equity. Self-development courses on engineering marketability was also identified as an important need.

The results of these surveys have led the WE Committee to develop a mentoring program, quarterly networking seminars, and projects that promote engineering as a career for women. The WE Committee is researching workshops on equity, refresher courses, and family leave and job share options.

WE would like to share our findings and gain knowledge from programs developed in other provinces and countries, especially those with small population bases.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

WOMEN IN RAILROADING
A NON-TRADITIONAL INDUSTRY FOR WOMEN

Fran Abramowitz

Le secteur en croissance le plus important de la main-d'oeuvre : les femmes et la tendance continue. Le CN, une industrie dominée traditionnellement par les hommes, a pris des mesures spécifiques ces 17 dernières années en vue d'étudier la situation des femmes au sein de la compagnie et de mettre en oeuvre des initiatives visant à accroître leur représentation à tous les niveaux.

Depuis le milieu des années 1970, la représentation des femmes a augmenté de 4 % à 8,1 %. Les changements d'attitudes et le contrôle étroit des initiatives visant spécifiquement à accroître la représentation des femmes aux différents niveaux de l'organisation sont les facteurs qui ont contribué à cette augmentation. Bien que lents, les progrès ont été constants.

Une Table ronde discussion aborde les diverses facettes de l'expérience du CN en matière de recrutement des femmes dans une industrie non traditionnelle pour les femmes et le défi de créer un milieu de travail dans lequel les femmes peuvent atteindre leur plein potentiel.

Les barrières relevés incluent le recrutement, les tests d'entrée inadéquats, le harcèlement, les communications sexistes, la culture globale de cette industrie et l'image du CN en tant qu'employeur de femmes.

Parmi les initiatives relatives aux sujets susmentionnés, notons :
- l'établissement d'un programme d'équité d'emploi formel;
- l'établissement d'objectifs d'embauche;
- le réseautage avec des groupes de femmes;
- des bourses d'études pour les femmes;
- une politique et une formation sur le harcèlement sexuel;
- la mise sur pied d'un groupe d'élaboration des tests;
- des directives sans distinction de sexe;
- des ateliers sur la diversité à l'intention des superviseurs.

En partageant ses expériences, le CN espère promouvoir une meilleure compréhension des questions d'équité, et encourager de nouvelles idées pour atteindre l'équité totale dans tous les milieux de travail.

WOMEN IN RAILROADING
A NON-TRADITIONAL INDUSTRY FOR WOMEN

Fran Abramowitz
Manager, Employment Equity
Canadian National, Montreal, Canada

ABSTRACT

The largest growing sector of the workforce is women and this trend continues. CN, a traditionally male dominated industry, has taken specific steps in the last 17 years to study the situation of women within the company and then put into place initiatives to increase representation at all levels.

Since the mid-seventies, the representation of women has increased from 4.0% to 8.1%. Attitudinal change and close monitoring of initiatives designed specifically to increase representation at different levels within the organization are the contributing factors. Progress has been steady, but slow.

A round table discussion sharing CN's experience of recruiting women into a non-traditional industry for women, and the challenges of creating a workplace in which the women can perform to their utmost.

Barriers and obstacles have been addressed which include recruitment, inappropriate entry level tests, harassment, sexist communications, the overall culture of this industry and the image of CN as an employer of women.

Initiatives addressing the above include:

- the establishment of a formal employment equity program;
- establishment of hiring targets;
- networking with women's groups;
- scholarships for women;
- sexual harassment policy and training;
- establishment of a test development group;
- gender-free guidelines;
- diversity workshops for supervisors.

By sharing direct experience, CN hopes to promote a better understanding of equity issues, as well as encourage new ideas for achieving true equity in the workplace.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

THE GLASS CEILING IN SCIENCE ACADEMIA FOR WOMEN

Peggy Tripp-Knowles, Lakehead University, Canada

Cet atelier inclura une brève présentation de documents sur les «travailleuses scientifiques en Amérique» (avec un accent sur le livre de Margaret Rossiter), une analyse statistique des femmes dans les programmes de sciences au Canada et une preuve expérientielle du plafonnement voilé. Cette table ronde mettra principalement l'accent sur une discussion entre les participantes et participants à propos de leurs expériences en matière de limitations de nos possibilités de carrière en sciences dans la structure universitaire des sciences.

This round table will include a short presentation of historical literature about "women scientists in America" (with an emphasis on Margaret Rossiter's book by the same name), a statistical analysis of women in science in Canadian academia and experiential evidence about the glass ceiling effect. The major focus of the round table presentation will be a discussion among the participants about their experiences with any restrictions on our goals for science careers operating within the science academic structure.

FAMILY SCIENCE

Sandra Bruzga, Giralang Primary School ACT Australia

Family Science est un projet éducatif national, conçu tout spécifiquement pour les jeunes filles. Il encourage les parents et leurs enfants à participer et à prendre plaisir à des expériences scientifiques. Le projet Family Science, un projet australien, a pour but d'encourager les familles à participer aux expériences scientifiques de leurs enfants en fournissant des ateliers de leadership à l'intention des parents, du personnel enseignant et d'autres adultes intéressés, de façon à ce que des programmes de sciences familiaux communautaires, conjoints au programme d'études plus formel des enfants, puissent être mis sur pied.

Family Science is a national educational project specifically targetting girls. It engages parents and their children in fun, hands-on science. The Family Science Project, Australia, aims to involve families in the science education of their children by providing leadership workshops for parents, teachers and other interested adults so that community based family science programs that complement the children's more formal curriculum can be established.

GENDER AND TECHNOLOGY STUDIES AT PRIMARY SCHOOL LEVEL - A BOOK AND AN INSERVICE COURSE FOR TEACHERS

Bev Dick et Jacqui Ryan

Des agentes et agents de projet du centre Hypatia's Place ont participé à la conférence GASAT 6 en 1991, qui les a inspirés à faire des sexes et de la technologie leur thème central pour 1992.

Au cours de cette année, on a mis au point et testé un cours de perfectionnement à l'intention des enseignantes et enseignants du palier primaire. Ce cours avait pour objectif d'aider les enseignantes et enseignants (pour la plupart des enseignantes) à mieux comprendre ce qu'est la technologie et la façon de l'enseigner sans distinction entre les sexes. L'enthousiasme et les réactions des participantes et participants face à l'amélioration de leurs propres aptitudes et de leur confiance en soi, et la rapidité à laquelle elles et ils ont transporté ces idées dans leurs salles de classe, reflètent le succès de ce cours.

Par après, le centre Hypatia's Place a écrit un livre intitulé *I Spy Technology* (publié en 1993), dans lequel on traite plus en détail des questions et activités du cours. Le livre décrit les barrières auxquelles peuvent se heurter les jeunes filles en technologie, ainsi que des stratégies pratiques et des idées de leçon pour surmonter ces barrières.

Dans cet atelier, des idées du livre et du cours interne seront présentées. Les participantes et participants participeront à des activités qui illustreront la façon dont les filles apprennent et la façon de valoriser les contributions actuelles et passées des femmes dans le domaine de la technologie.

Hypatia's Place - Maths, Science, Technology Education Centre for Girls a été créé par le gouvernement de Victoria en 1991 en vue de promouvoir l'enseignement sans distinction des sexes des mathématiques, des sciences et de la technologie. Le centre emploie actuellement trois agent(e)s de projet - dont un(e) agent(e) du McClintock Collective Project - et considère le développement professionnel des enseignantes et enseignants comme une priorité très importante.

GENDER AND TECHNOLOGY STUDIES AT PRIMARY SCHOOL LEVEL A BOOK AND INSERVICE COURSE FOR TEACHERS

Bev Dick and Jacqui Ryan, Hypatia's Place - the Maths, Science, Technology Education Centre for Girls
(Victoria, Australia)

Project officers from Hypatia's Place attended GASAT 6 in 1991 and were inspired to make gender and technology their major focus for 1992.

During that year a professional development course for primary teachers was developed and trialled. It aimed to support teachers (who were mostly women) in understanding what technology is and how to teach it in a gender inclusive way. Enthusiastic participation and feedback from participants about their personal increase in skills and confidence and the speed at which they took the ideas into their classrooms, indicated the success of the course.

Subsequently Hypatia's Place has written a book entitled I Spy Technology (published 1993) in which issues and activities from the course have been elaborated. The book outlines potential barriers for girls in technology and includes a comprehensive description of practical strategies and lesson ideas for countering these barriers.

In this workshop ideas from both the book and inservice course will be presented. Participants will experience activities that will exemplify the 'ways girls like to learn' and how to value the contributions women make and have made to the area of technology.

Hypatia's Place - the Maths, Science, Technology Education Centre for Girls was set up by the Victorian State Government in 1991 to assist in the development of gender inclusive education in maths, science and technology. The centre is currently staffed by three project officers--including the McClintock Collective Project Officer--and sees professional development of teachers as a high priority.

LINKING ELEMENTARY SCHOOL TEACHERS & STUDENTS TO THE FACULTIES OF SCIENCE & ENGINEERING

Karen Hansen

Discovery Western est un camp de jour de génie dirigé par des élèves-ingénieures et élèves-ingénieurs au niveau du baccalauréat de l'University of Western Ontario. Le programme d'été, d'une durée de quatre mois, est conçu à l'intention des étudiantes et étudiants des classes de la cinquième à la huitième années, et a pour but de les encourager à en apprendre davantage sur les sciences et le génie. Discovery Western est divisé en trois volets : ateliers, camps de jour et ateliers à l'intention du personnel enseignant.

1. Ateliers (mai et juin)

Un couple d'instructeurs (une femme et un homme) conduisent un atelier pratique de deux heures dans les écoles élémentaires de la région de London. Les enfants participent aux démonstrations et à des projets de construction en groupe.

2. Camps de jour (juillet et août)

Les enfants visitent l'université pendant une semaine et reçoivent chaque jour le matériel nécessaire pour mener à bien les projets pratiques, en se fondant sur les principes de base du génie.

3. Ateliers à l'intention du personnel enseignant (fin du mois d'août)

Discovery Western suivra l'idée du département de physique de l'UWO en enseignant, dès cet été, au personnel enseignant. Dans le cadre du cours de physique, quatre professeur(e)s, un(e) étudiant(e) diplômé(e) et moi-même avons participé à deux séries de quatre ateliers. Le principal objectif était d'aider à mieux comprendre et utiliser la trousse «World in Motion» (un monde en mouvement). Bien qu'élaborée par des ingénieur(e)s, cette trousse, adaptée pour les élèves de la quatrième à la sixième année, comportait des explications vagues, pouvant facilement être mal interprétées. Tout au long des quatre ateliers, on a découvert que les enseignantes et enseignants souhaitaient discuter de préoccupations autres que celles relatives à la trousse. Discovery Western a prévu un atelier pour les enseignantes et enseignants pour la fin du mois d'août, cet été.

Dans le cadre de l'atelier du colloque GASAT, les participantes et participants pourront apprécier des activités pratiques et des démonstrations semblables à celles destinées au personnel enseignant. Vous n'aurez plus qu'à vous asseoir bien confortablement, à vous détendre -- peut-être même à prétendre que vous avez dix ans pendant quelques instants. On vous encouragera à poser des questions et on y répondra, et on vous parlera plus en détail du camp Discovery Western.

LINKING ELEMENTARY SCHOOL TEACHERS & STUDENTS TO THE FACULTIES OF SCIENCE & ENGINEERING

– WORKSHOP –

KAREN HANSEN, DIRECTOR OF *DISCOVERY WESTERN*

Discovery Western is an engineering day camp run by undergraduate engineering students at the University of Western Ontario. The four month summer program is aimed at students in grades five to eight with a goal of instilling these children with a desire to know more about the world of science and engineering. Discovery Western runs in three phases: workshops, day camps, and teachers workshops.

1. Workshops (May and June)

Pairs of instructors (one male and one female) perform a two hour, hands on workshop at elementary schools in the greater London area. Children participate in demonstrations and take part in group building projects.

2. Day Camps (July and August)

Children visit the university for a week per camp. Each day, children are given the materials to complete hands on projects utilizing the fundamentals of engineering .

3. Teachers Workshop (End of August)

Discovery Western will be following the lead of the Physics department at U.W.O. in the teaching of teachers starting this summer. In Physics, four professors, one graduate student, and myself were involved in two sessions of four workshops. The main objective was to aid in the understanding and use of the "World in Motion" kit. Although written by engineers, this grade four to six level kit was vague in its explanations and easy to misinterpret. Throughout the four workshops, it was found that teachers wanted more of their concerns addressed than just what was in the kit. Discovery Western is now planning a workshop for teachers at the end of August this summer.

During the GASAT workshop, participants will enjoy hands on activities and demonstrations similar to those given to teachers. You will sit back, relax –'maybe even pretend you are ten years old for awhile. Questions will be encouraged and answered as we go and the running of Discovery Western will be discussed in as much detail as is requested.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

IGNITING THE SPARK: CLASSROOM PRACTICES FOR ENCOURAGING TRANSITION YEARS*FEMALE STUDENTS IN SCIENCE AND TECHNOLOGY STUDIES

Christine Hill

Cet atelier pratique a été conçu pour partager les expériences réelles en classe reflétant un effort concerté, afin d'encourager les étudiantes et étudiants dans leurs années de transition à se lancer dans le secteur des sciences et de la technologie.

La présentation fait la démonstration des résultats d'une variété de stratégies pédagogiques visant à favoriser un climat d'apprentissage des sciences et de la technologie dans lequel on ne fait aucune distinction de sexe. La personne responsable de la présentation offre un présentoir multimédia de produits pour étudiantes et étudiants, ses observations sur les méthodes d'apprentissage des étudiantes qui se lancent dans des études de science ou de technologie et des exemples de tâches en classe qui intègrent l'interrogation scientifique et la technologie des conceptions aux programmes d'arts traditionnels.

L'atelier tient compte des expériences des étudiantes et étudiants dans la mise en oeuvre d'un concept de «défi à la conception» et examine de près les réactions des étudiantes à l'égard des stratégies de motivation et la structure même de la compétition.

L'atelier a pour thème général l'importance cruciale d'une intervention efficace dans les années de transition, de façon à assurer la validation des diverses expériences des étudiantes et de donner la possibilité aux jeunes filles de tirer parti des richesses du domaine des sciences et de la technologie.

* Classes ontariennes de 7e, 8e et 9e années. Cet atelier traite principalement des activités dans les classes de 7e et de 8e années.

IGNITING THE SPARK: CLASSROOM PRACTICES FOR ENCOURAGING TRANSITION YEARS*FEMALE STUDENTS IN SCIENCE AND TECHNOLOGY STUDIES

Christine Hill, Intermediate Division Teacher,
Prescott-Russell County Board of Education

This hands-on workshop is designed to share actual classroom experiences which reflect a concerted effort to encourage Transition Years students in science and design technology activities.

The presentation will demonstrate the results of a variety of teaching strategies aimed at creating a gender-inclusive science and technology learning environment. The presenter will offer a multi-media display of student products, observations on the learning processes of female students approaching scientific or technological tasks in curriculum areas and examples of classroom tasks which integrate scientific inquiry and design technology with traditional arts curricula.

The workshop will highlight student experiences in the implementation of a "design challenge" concept in one school and will examine closely female students' responses to motivational strategies and the construct of competition itself.

The unifying theme of the workshop is the crucial importance of energetic intervention in the Transition Years to ensure that the diverse experience of female students is validated and to empower young girls to share in the wealth of learning in science and technology.

*Ontario Grades 7, 8 and 9. This workshop deals specifically with classroom activities in Grades 7 and 8.

EMPOWERMENT THROUGH TECHNOLOGY

Valerie C. Johnston

L'expertise technologique, plus particulièrement avec les ordinateurs et la manipulation de l'information, fait désormais partie des connaissances élémentaires des apprenantes et apprenants de tout âge. Le gouvernement provincial, par le biais du ministère de l'Éducation, s'efforce d'encourager les conseils scolaires à mettre en oeuvre cette technologie en évolution constante pour habiliter tant les apprenantes et apprenants que le personnel enseignant. Quels sont les défis et les pièges auxquels nous nous heurtons dans le milieu d'apprentissage moyen de nos écoles? Les ordinateurs sont des outils qui rehaussent l'expérience d'apprentissage, pour autant que les logiciels ne comportent aucun parti pris et soutiennent les divers styles d'apprentissage.

Cet atelier multi-média aborde les questions suivantes : enseignement aux paliers élémentaire et secondaire et éducation des adultes, avec des exemples de la façon dont certains conseils scolaires surmontent les obstacles rencontrés : dans le cadre de la formation en cours d'emploi; en raison de logiciels et de matériel inadéquats; et en raison de ressources financières toujours plus maigres pour habiliter les apprenantes et apprenants de tous les niveaux à saisir les questions de technologie.

EMPOWERMENT THROUGH TECHNOLOGY

Valerie C. Johnston

Oxford County Board of Education

WORKSHOP

Technological expertise, particularly with computers and information manipulation, is now a life skill for learners of all ages. The provincial government, through the Ministry of Education, is striving to guide school boards in the implementation of this rapidly-changing technology to provide empowerment required by both the learner and the teacher. What are the challenges and pitfalls facing the average learning environment in our schools? Computers can be a tool to enhance the learning experience if software is unbiased and supports the various learning styles.

This multi-media workshop will span the various panels: elementary, secondary, and adult education, giving examples of how some boards are overcoming obstacles in: teacher in-service; inappropriate software and hardware; and the ever dwindling financial resources required to provide opportunity for technological empowerment for learners at all levels.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

XEROX POSTER ART: DEFINING A FEMINIST SCHOOL/WORKPLACE

Lynne Joslyn

Je suis professeure de sciences à l'école secondaire Fort Street (FSHS), une école publique mixte située dans le centre de la zone urbaine. Pour exprimer mon intérêt à l'égard de la question de l'égalité des sexes, j'ai coordonné le Girls Discussion Group, une initiative d'enseignement féministe directe avec un groupe d'intérêt particulier formé d'étudiantes.

Dans le cadre de nos efforts visant à transformer les sentiments de colère et de vulnérabilité des filles en une certaine prise de pouvoir, nous avons conçu de grandes affiches sur la question de l'égalité des sexes. Nous affichons une affiche à la fois sur un mur d'un endroit très achalandé de notre école. Les affiches sont pleines d'audace et impudentes, pleines de colère et bien articulées, amusantes et capricieuses. Les gens recherchent nos affiches, les gens détestent nos affiches, les gens parlent de nos affiches, les gens nous volent nos affiches. Tout cela pour dire que nos affiches font une différence et que nous en sommes fières.

Les affiches demandent que l'école se mette à l'écoute d'un point de vue féministe. Elles établissent le caractère légitime des questions féministes. Les affiches diffusent notre message dans tout le milieu scolaire.

Je vous propose l'atelier «Xerox Poster Act: Defining a Feminist School/Workplace». Il a pour objectif de vous faire partager mes expériences relatives à l'habilitation des filles, en modifiant la politique du milieu de travail et l'ordre du jour en faveur des questions d'égalité.

L'atelier comprendrait les éléments suivants :

1. Affichage de nos affiches.
2. Historique de cette «forme d'art» à la FSHS.
   - rôle de l'art thérapie;
   - réactions à l'égard des affiches (officielles et autres);
   - analyse féministe des réactions aux affiches.
3. Remue-méninges relatif à l'affiche.
4. Fabrication libre d'affiches.

XEROX POSTER ART: DEFINING A FEMINIST SCHOOL/WORKPLACE

Lynne Joslyn, Fort Street High School, Petersham, Australia

I am a secondary science teacher at Ford Street High School, an inner-city selective coed public school. As an expression of my interest in gender equity, I have been coordinating the "Girls Discussion Group", a direct feminist education initiative with a special interst group of female students.

As part of our focus on translating girls feelings of anger and vulnerability into empowerment, the girls construct large posters addressing gender equity issues. We display one poster at a time on a wall in a well-trodden zone of our school. The posters are bold and brazen, angry and articulate, amusing and quirky. People look forward to our posters, people hate our posters, people discuss our posters, people steal our posters. In short we are proud of our impact.

The posters demand that the school hear a feminist perspective. They establish the legitimacy of girls' issues. The posters spread the message of the group beyond the girls only space where they are made into the wider school environment.

I proposed to run a workshop "Xerox Poster Art: Defining a Feminist School/Workplace". The objective of the workshop is to share my experiences in empowering girls, altering the politic of the work environment and changing the agenda in favour of equity issues.

The workshop would consist of:

1. Display of our posters
2. History of this "art form" at FSHS
   - role of art therapy
   - response to posters (official and otherwise)
   - feminist analysis of response to posters
3. Brainstorming a poster
4. Free-form poster making.

MAKING CONNECTIONS: A FEMINIST PERSPECTIVE

Cheryl Kristjanson

L'atelier intitulé Making Connections: A Feminist Perspective financé par la Walter and Duncan Gordon Foundation est fondé sur les conclusions du projet pilote d'élaboration de stratégies d'apprentissage et d'enseignement sans discrimination des sexes. Ce projet pilote a été mis sur pied en réponse aux nombreuses études de recherche qui révèlent une forte disparité dans les niveaux d'accomplissement, d'aspiration et de confiance entre les hommes et les femmes, dans les domaines des mathématiques et des sciences.

Le projet pilote avait été fondé sur une approche théorique reposant sur les faits, et visait à examiner et à établir si les conclusions des études courantes se reflétaient également dans la vie de nos étudiantes. La réponse est positive. Dans le cadre de sondages et d'entrevues conduits auprès d'étudiantes pour évaluer leurs expériences en classe, nous leur avons demandé de définir les facteurs critiques qui devraient être pris en compte. Nous avons découvert trois connexions principales essentielles au processus d'apprentissage :

1. Une connexion entre l'étudiante et l'enseignante ou enseignant.
2. Une connexion entre la matière enseignée et l'étudiante.
3. Une connexion entre la matière enseignée et la réalité.

L'atelier abordera ces questions par le biais de :

1. Une discussion sur les différents styles et préférences d'apprentissage des étudiantes et une occasion pour les participantes et participants de l'atelier d'analyser leurs propres préférences.
2. Des exemples de diverses stratégies d'enseignement mises au point pour faire une connexion entre les étudiantes et les matières enseignées.
3. Une occasion pour toutes les participantes et tous les participants d'élaborer des exemples de leçons qui font une connexion entre elles-mêmes et leurs étudiantes, ainsi qu'avec le monde réel.

L'atelier se terminera par une discussion de groupe sur la façon dont les enseignantes et enseignants peuvent, sans modifier leur style personnel d'enseignement, réaliser ces connexions avec leurs étudiantes.

MAKING CONNECTIONS: A FEMINIST PERSPECTIVE

Cheryl Kristjanson

Daniel McIntyre High School, Winnipeg, Manitoba

Making Connections: A Feminist Perspective workshop is based on the findings of the gender inclusive teaching and learning strategies pilot project funded by the Walter and Duncan Gordon Foundation. This pilot project was developed to respond to the numerous research studies that indicate there is a disparity in the achievement, aspiration and confidence levels between males and females in the areas of math and science.

The pilot project applied a grounded theory approach to observe and assess whether current research findings existed in the lives of our female students. The reality was that they did. Through a further process of surveying and interviewing female students about their classroom experiences we asked them to identify critical factors that needed to be addressed. We found that three main connections are essential to their learning process:

1. A connection between the student and the teacher.
2. A connection between the subject area and the student.
3. A connection between the subject area and real life.

The workshop will develop these issues through:

1. A discussion of different learning styles and preferences of female learners and an opportunity for workshop participants to analyze their own preferences.
2. Examples of varied teaching strategies developed to make connections with female students and subject areas.
3. An opportunity for participants to develop sample lessons that make connections between themselves and their students as well as the real world.

The workshop will conclude with a group discussion on how teachers can work within their own personal style to make these connections with their students.

BECOMING ADEPT AND COMFORTABLE WITH SCIENCE AND TECHNOLOGY CURRICULUM

Groupe-clé «Here Today... Where Tomorrow?»

Généralités : Cet atelier est basé sur des expériences tirées d'une initiative d'intervention d'une collectivité rurale, organisée et offerte par un comité directeur composé de membres d'un collège, de trois conseils scolaires, d'organismes d'enseignantes et enseignants et d'entreprises locales.

Atelier : L'atelier pratique combine des questions théoriques et pratiques pour exposer les défis auxquels se heurtent les filles et les professeures et professeurs de sciences et de technologie. Les participantes et participants seront guidés au travers d'un procédé d'acquisition d'aptitudes de base; on leur présentera différentes méthodes artisanales, du matériel et des normes ind[illegible]els; elles et ils feront connaissance avec les sciences appliquées et les mathématiques pendant qu'elles et ils construisent un carillon éolien.

Parmi les objectifs de l'atelier, notons :

- démontrer une approche visant à égaliser l'exposition des filles aux sciences et à la technologie afin de développer chez elles des aptitudes artisanales, la confiance en soi et d'augmenter leurs possibilités de carrière/d'apprentissage;
- fournir la possibilité d'envisager comment nos expériences peuvent se transformer en ressources dans la planification quotidienne du programme d'études;
- fournir des listes de vérifications qui permettent aux participantes et participants de contrôler les interactions à accès égal dans un milieu d'apprentissage mixte; et
- prendre en compte des stratégies pour soutenir et encourager la participation des filles dans les activités scientifiques et techniques.

Structure :
Cet atelier est le premier de trois volets intégrés au colloque GASAT 7. Les deux autres consistent en une démonstration pratique du mobile «Here Today... Where Tomorrow?» et d'unités portatives de programme internes, et en une discussion intitulée Extending Options to Kindle Interests and Aspirations in Science and Technology.

BECOMING ADEPT AND COMFORTABLE WITH SCIENCE AND TECHNOLOGY CURRICULUM

"Here Today...Where Tomorrow?" Resource Team

Background: This workshop is based upon experiences derived from a rural, community-based intervention initiative that was organized and delivered by a Steering Committee composed of members from a college, three school boards, teachers' organizations and local business.

Workshop: The hands-on workshop combines theoretical and practical issues to expose the challenges facing girls and educators in science and technology. Participants will be guided through a generic tool skill process, introduced to craft-based methods, industrial materials and standards, and experience applied science and math as everyone successfully constructs a musical windchime.

Goals of the workshop include:

- demonstrating an approach to equalize girls' exposure to science and technology in order to develop craft-based skills, self confidence, and expand future career/learning possibilities:
- providing the opportunity to consider how our shared experiences can be resources for everyday curriculum planning;
- offering checklists that enable participants to monitor equal access interactions in a mixed learning environment; and,
- considering strategies to support and encourage the involvement of girls in science and technical activities.

Structure:

This workshop is the first part of three integrated GASAT 7 conference presentations. The other two segments are: a hands-on demonstration featuring "Here Today...Where Tomorrow?" mobile and portable in-school program units; and, a roundtable session Extending Options to Kindle Interests and Aspirations in Science and Technology.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

SCIENCE TEAMS

Rebecca L. Lubetkin
Marilyn A. Hulme

Le programme Science Teams, un programme de formation novateur destinés aux enseignantes et enseignants du palier élémentaire, fait appel à deux concepts bien documentés, l'apprentissage collectif et les sciences pratiques, en vue de promouvoir l'intérêt, l'engagement et l'accomplissement des étudiantes et étudiants - et plus particulièrement des pauvres, des immigrantes et immigrants, des femmes et des minorités visibles, qui sont sous-représentés parmi les adultes qui poursuivent une carrière en sciences. Grâce à des fonds publics et privés, Science Teams est devenu le premier effort officiel d'un État américain visant à combiner l'apprentissage collectif à la formation en sciences pratiques.

Les objectifs de ce programme sont les suivants :

- Apprendre aux enseignantes et enseignants à améliorer la qualité des cours de sciences pratiques et à augmenter la durée des expériences pratiques des étudiantes et étudiants.
- Rehausser les aptitudes en gestion de la salle de classe des enseignantes et enseignants par le biais de stratégies d'apprentissage collectif en vue de promouvoir l'entraide et d'améliorer les performances.
- Fournir des stratégies aux enseignantes et enseignants en vue d'intégrer les renseignements professionnels et les questions sociétales dans les cours de sciences.
- Réduire les attentes et le traitement discriminatoires fondés sur le sexe, la race ou l'ethnie, et promouvoir la collaboration entre les équipes.
- Améliorer les connaissances scientifiques et les aptitudes à enseigner les sciences environnementales des enseignantes et enseignants.

Une étude de deux ans sur l'impact du programme Science Teams sur les enseignantes et enseignants et étudiantes et étudiants participants a révélé que, comparativement aux autres, les élèves qui ont participé au projet Science Teams avaient de meilleures attitudes à l'égard des sciences; étaient plus à l'aise avec les sciences; et participaient à plus d'expériences scientifiques et à plus d'activités en petits groupes. En outre, les enseignantes et enseignants de Science Teams offrent davantage d'activités reliées aux carrières et d'activités spéciales visant à intéresser les filles et les garçons des minorités aux sciences.

Des séquences de la bande vidéo Science Teams, gagnante du prix Bronze Apple lors du National Educational Film and Video Festival, seront présentées.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

SCIENCE TEAMS

Rebecca L. Lubetkin, Marilyn A. Hulme,
Rutgers University, New Brunswick, NJ USA

Science Teams, an innovative training programs for elementary teachers, applies two well-researched concepts, cooperative learning and hands-on science, to promote the interest, engagement, and achievement of students--especially the poor, immigrant, female and minority populations, who are underrepresented among adults who pursue science careers. Through a combination of public and private funding, Science Teams is the first formal statewide effort in the U.S. to combine cooperative learning and hands-on science training. Objectives are:

- To train teachers in improving the quality of hands-on science and to increase the amount of time that students are actively engaged in conducting experiments.
- To improve teachers' classroom management skills through the use of cooperative learning strategies to promote student peer support for improved achievement.
- To provide strategies for teachers to integrate career information and societal issues into the science class.
- To reduce differential expectations and treatment of students based on sex, race, or ethnicity, and to promote intergroup cooperation.
- To improve teachers' science knowledge and instructional skills in environmental science.

A two-year study of the impact of Science Teams on participating teachers and students indicates that, compared to others, Science Teams students: have more positive attitudes toward science; are more comfortable doing science; do more hands-on science and more small group work. In addition Science Teams teachers do more career activities and special activities to encourage girls and minority boys in science.

Clips from the Science Teams video, winner of the Bronze Apple in the 1992 National Educational Film and Video Festival, will be shown.

WAMMO - THE CAREER GAME

Janet Mays and Rosemarie Volpe

WAMMO, acronyme pour «Women Advancing Men Move Over», est un jeu de table conçu dans le cadre du projet de camp d'été «Discover Engineering» de l'Institut polytechnique Ryerson.

Le jeu, qui se joue en équipes de 10 personnes, offre un format amusant et éducatif visant à incorporer les questions féminines dans le projet de camp. Étant donné que les équipes doivent collaborer pour trouver les réponses, l'activité encourage l'interaction et la résolution collective de problèmes. Son efficacité suggère que le concept est possible dans divers contextes éducatifs.

L'objet de ce jeu est de se rendre du point de départ (Start) au point d'arrivée (Finish) sur un grand plateau déposé à même le sol en répondant correctement à des questions tirées de cinq domaines :

- les femmes dans la main-d'oeuvre rémunérée;
- les femmes dans le génie et les sciences appliquées;
- les femmes en éducation;
- les femmes et la vie de famille;
- les stéréotypes et autres images.

La catégorie des questions est établie en roulant un gros dé qui comporte le nom d'une des cinq catégories ci-dessus sur chacune de ses faces. (La sixième face indique de choisir sa propre catégorie.) Une réponse correcte permet à l'équipe d'avancer d'un certain nombre de cases, selon la complexité de la question.

D'autre part, le jeu contient un certain nombre de carrés étiquetés «Tootsie Roles», «Mothers of Invention» ou «Pink Collar Blues». Lorsqu'une équipe tombe sur une de ces cases, un scénario pertinent est décrit, qui invite l'équipe à avancer, à reculer ou à perdre un tour. La première équipe qui atteint le point d'arrivée est déclarée gagnante.

Cet atelier est largement expérientiel.

WAMMO - THE CAREER GAME

Created by: Janet Mays and Rosemarie Volpe
Ryerson Polytechnical Institute
350 Victoria Street
Toronto, Ontario M5B 2K3

WAMMO, an acronym for "Women Advancing Men Move Over", is a board game developed as a component of Ryerson Polytechnical Institute's "Discover Engineering" summer camp project.

The game, which was designed to be played by teams of up to 10 individuals, provides both an entertaining and educational format for incorporating women's issues into the camp program. Since teams must collaborate in determining their responses, the activity promotes interaction and cooperative problem solving. Its effectiveness suggests that the concept would have similar application in diverse educational contexts.

The object of the game is for teams to proceed from "Start" to "Finish" along a large gameboard situated on the floor. This is accomplished by successfully responding to questions from five subject areas:

- Women in Paid Labour Force
- Women in Engineering and Applied Science
- Women in Education
- Women and Family Life
- Stereotypes and Other Images.

The question category is established by rolling a large die labelled on each side with one of the above. (The sixth side indicates "Choose Your Own Category".) A correct response allows teams to advance a designated number of spaces, depending on the complexity of the question.

In addition, the gameboard contains a number of squares labelled "Tootsie Roles", "Mothers of Invention", or "Pink Collar Blues". If a team lands on one of these, a relevant scenario is described and the team is directed to advance, retreat or lose a turn. The first team to reach "Finish" is declared the winner.

This workshop will be largely experiential.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

AN INTRODUCTION TO THE MCCLINTOCK COLLECTIVE SCIENCE TEACHING STRATEGIES

Le McClintock Collective

Le McClintock Collective est un réseau de professeures et professeurs de sciences basé à Victoria, en Australie, qui tente, depuis 1983, d'élaborer certaines approches à l'enseignement et d'en améliorer d'autres de façon à rendre l'enseignement des sciences plus pertinent et plus adapté aux besoins des filles.

Le McClintock Collective a mis au point une vaste gamme de stratégies d'enseignement qui mettent au défi le contenu des programmes d'études, les approches à l'apprentissage et les méthodes d'évaluation actuelles. L'idée que les sciences sont un domaine choisi tant par les femmes que par les hommes, plutôt que seulement par les hommes, est présentée. Les stratégies en salle de classe du McClintock Collective reconnaissent et se basent sur ce que les filles font bien, comme de discuter, de partager des idées et d'être créatives; les façons d'apprendre préférées des filles, comme par le biais de la collaboration, et d'approcher un problème scientifique de différents points de vue; l'intérêt des filles envers la pertinence des sciences par rapport à leurs besoins et à leur impact sur la société et sur l'environnement; et enfin, le besoin de soutenir et d'encourager activement les filles dans des domaines d'apprentissage quasiment inconnus d'elles, tels que l'électricité, l'électronique, la mécanique et l'utilisation d'outils et de machines divers.

Ces approches, et bien d'autres, sont partagées régulièrement dans le cadre de programmes internes destinés au personnel enseignant, et sont à la base du livre du McClintock Collective *Getting Into Gear*, publié pour la première fois en 1988 avec l'aide du gouvernement fédéral.

Cet atelier présente quelques stratégies d'enseignement pratiques qui ont permis de transformer la façon du personnel enseignant d'élaborer les expériences d'apprentissage de leurs élèves. Les participantes et participants en apprendront davantage sur ces stratégies d'enseignement et discuteront ensemble de leur potentiel.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

AN INTRODUCTION TO THE MCCLINTOCK COLLECTIVE SCIENCE TEACHING STRATEGIES

McClintock Collective, West Melbourne

The McClintock Collective is a network of science teachers based in Victoria Australia who have been working, since 1983, to develop and refine approaches to teaching that will make science education more relevant and responsive to the needs of girls.

The McClintock Collective has developed a wide range of teaching ideas that challenge current science curriculum content, approaches to learning and assessment methods. The view that science is practiced by and for both males and females, rather than just males, is presented. McClintock classroom strategies recognise and build on the things girls do well, such as discussing, sharing ideas and being creative; the ways girls like to learn, such as through collaboration and looking at a scientists' problem from many viewpoints; on girls' interest in the relevance of science to them and its implications for society and the environment; and on the need to support and actively encourage girls in areas of learning they may have little background experience in, such as electricity, electronics, mechanics and tinkering with tools and machinery.

These and other approaches are shared regularly through inservice programs for teachers and are the basis of the Collective's book Getting Into Gear first published in 1988 with federal government assistance.

This workshop will present a few of the practical teaching strategies that have been successful in reshaping the way teachers construct the learning experiences for their students. Participants will experience the strategies and discuss their potential.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

A GENDER AND SCIENCE COURSE FOR TEACHERS: THE McCLINTOCK COLLECTIVE STRUCTURED COURSE

McClintock Collective

Le McClintock Collective est un réseau d'éducatrices et éducateurs du Victorian Department of School Education qui travaillent en commun pour parvenir à un enseignement des sciences sans distinction des sexes. Le McClintock Collective est financé par le gouvernement de Victoria et son adresse est la suivante : Hypatia's Place -- Science, Maths, Technology Education Centre for Girls, 270, rue Highett, Richmond 3121, Victoria, Australie. Notre première publication, *Getting Into Gear*, est basée sur les stratégies d'enseignement développées par le McClintock Collective en vue d'encourager les jeunes filles à envisager un apprentissage ou une carrière dans le domaine des sciences.

Le McClintock Collective a élaboré un bref cours d'enseignement des sexes, des sciences et de la technologie à l'intention des enseignantes et enseignants du palier secondaire. Ce cours, offert trois heures par semaine après les heures d'école, dure six semaines. Les six séances permettent aux participantes et participants de modifier progressivement leurs pratiques d'enseignement par le biais de quelques procédures de recherche active.

Dans le cadre de ce cours, les participantes et participants examinent certains des obstacles auxquels se heurtent les jeunes filles qui s'intéressent aux sciences, et les stratégies visant à les surmonter. Ce cours permet de développer, de tester, de faire état et d'améliorer les activités d'une séance à l'autre. Le cours incorpore la recherche-action, la création d'un milieu d'apprentissage de collaboration, les stratégies d'enseignement du McClintock Collective, l'évaluation et la conception du programme d'études. Les questions abordées comprennent l'élaboration d'un programme d'études et de pratiques d'enseignement sans distinction des sexes et l'évaluation.

On donnera des exemples du programme pendant l'atelier.

A GENDER AND SCIENCE COURSE FOR TEACHERS: THE MCCLINTOCK COLLECTIVE STRUCTURED COURSE

The McClintock Collective

The McClintock Collective is a network of educators working towards gender inclusive science education in the Victorian Department of School Education. The McClintock Collective is funded by the Victorian Government and located at Hypatia's Place, Science, Maths, Technology Education Centre for Girls, 270 Highett Street, Richmond 3121, Victoria, Australia. Our first publication, Getting Into Gear, is based on teaching strategies developed by the Collective to involve girls in learning science and to encourage girls to contemplate scientific careers.

The McClintock Collective has developed a short course in gender, science and technology education for secondary science teachers. It is conducted for three hours per week, out of school time, for six weeks. The six sessions provide participants with an opportunity to be guided and supported in changing their teaching practice through action research procedures over a period of time.

In the course participants explore some of the barriers to the participation of girls in science and strategies for overcoming them. Opportunities are provided to develop, trial, report and refine the activities from one session to the next. The course incorporates action research, creating a supportive learning environment, the McClintock Collective's teaching strategies, assessment and curriculum design. The issues covered include construction of gender, gender inclusive curriculum development and teaching practice, and assessment.

The workshop will include examples of the program.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

COMETS, an Intervention Strategy to Encourage Early Adolescent Girls in Science

Walter S. Smith

Cet atelier à participation du public présentera COMETS (Career Oriented Modules to Explore Topics in Science) aux participantes et participants, une publication de la National Science Teachers Association mise au point à l'University of Kansas grâce au financement de la National Science Foundation et de la fondation privée TRW. COMETS est utilisé dans les classes de la 5e à la 9e années pour montrer aux étudiantes et aux étudiants, mais plus particulièrement aux étudiantes, que l'étude des sciences est essentielle à leur succès professionnel, quelle que soit la carrière de leur choix, pas seulement pour les carrières de chercheuse, physicienne ou ingénieure.

COMETS Science contient plus de 100 activités pratiques associées à des sujets et carrières scientifiques, organisées en 24 modules, permettant aux enseignantes et enseignants d'utiliser COMETS dans le cadre de leurs programmes de sciences. COMETS Science contient également des renseignements sur plusieurs douzaines de femmes récipiendaires du Prix Nobel ou qui ont reçu des distinctions semblables, qui permettent aux étudiantes et étudiants d'apprendre enfin que Marie Curie n'est pas la seule femme à avoir apporté sa contribution au domaine des sciences. Un livre intitulé COMETS Profiles, contient 24 résumés biographiques sur des femmes «typiques» à l'intention des étudiantes et étudiants . Chaque profil comprend une preuve directe ou indirecte de l'emploi des sciences par la femme. Des activités d'arts du langage accompagnent chaque profil de façon à ce que COMETS puisse être utilisé dans les classes d'arts du langage et de sciences, ou à l'extérieur des classes de sciences formelles, dans le cadre de programmes d'intervention visant à encourager les femmes à s'intéresser aux sciences.

COMETS, an Intervention Strategy to Encourage Early Adolescent Girls in Science

Walter S. Smith
University of Kansas, Lawrence, Kansas, United States of America

This audience-participation workshop will introduce participants to COMETS, Career Oriented Modules to Explore Topics in Science, a publication of the National Science Teachers Association and developed at the University of Kansas with funding from the federal National Science Foundation and the private TRW Foundation. COMETS is designed for use in grades 5-9 to show all students, especially girls, that science study is a prerequisite to success in all careers, not just those such as researcher, physician, or engineer that people typically associate with science.

COMETS Science contains over 100 hands-on science activities keyed to science topics and careers organized into 24 modules so that teachers can use COMETS to supplement their science instruction in a variety of areas. COMETS Science also contains information about several dozen women who have won the Nobel Prize or achieved similar distinction so that students learn that "more women than only Marie Curie have contributed to science." A coordinated book, COMETS Profiles, contains 24 biographical sketches about "everyday" women to be read by students. Each profiles includes direct or indirect evidence of the woman's use of science. Language arts activities accompany each profile so that COMETS can be used in either language arts or science classrooms or outside formal science classrooms in intervention programs to encourage women in science.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

OPERATION FIND

Mable D. Jones

Operation Find est conçu pour celles et ceux qui ne sont jamais parvenus à surmonter les obstacles auxquels elles et ils se sont heurtés et à transformer leurs rêves en réalité. Il arrive souvent que les gens soient prêts à faire des choix mais que les moyens leur manquent et qu'ils passent entre les mailles du système.

Si les gens estiment ne pas être en mesure de faire quelque chose ou craignent de le faire, alors il devient difficile de leur faire faire quoi que ce soit. Operation Find met au défi la perception qu'ont les gens d'eux-mêmes et ouvre leurs esprits à des idées et croyances positives. Les participantes et participants à ce projet en ressortiront avec un sentiment d'assurance qui les aidera à modifier leurs attitudes et à réaliser leurs objectifs.

L'Église représente une toile de fond sans menace pour les personnes qui ont des besoins spéciaux. C'est pourquoi elles seront testées et formées (dans la mesure du possible) dans un cadre religieux.

Operation Find prévoit un taux de réussite de 100 %; soyons toutefois réalistes... 85 à 90 % serait déjà une belle réussite.

OPERATION FIND

Mable D. Jones

Operation Find is a pilot project that was proposed to McDonnell Douglas, Macon by Macedonia Baptist Church.

Operation Find is designed for individuals who have not been able to overcome barriers and get beyond their broken dreams. Oftentime, people are ready to choose but because there is no vehicle available to assist them they fall through the cracks of the system.

If people believe they cannot do something or they are afraid to do something, then it is hard to get them to do anything. Operation Find will challenge people's perception of themselves and open their minds to positive ideas and beliefs. They will come out of this project with a feeling of self assuredness that will help them change within themselves and accomplish their goals.

The Church represents a non-threatening back drop for special needs persons, so they will be tested and trained (where possible) in the Church setting.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Transformer les sciences et la technologie : notre avenir en dépend

Volume 1
Les Soumissions à septième Conférence internationale sur l'équité des sexes en sciences et en technologie

Transforming Science And Technology: Our Future Depends On It

Volume 1
Contributions to the Seventh International Gender and Science and Technology Conference

Editors

Sharon Haggerty
University of Western Ontario
London, Ontario

Ann Holmes
Ontario Women's Directorate
Toronto, Ontario

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The University of/l'Université de Waterloo
Waterloo Ontario Canada

31/07/93 - 05/08/93

583

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584

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Ontario
Women's
Directorate

Direction générale
de la condition féminine
de l'Ontario

585

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Transformer les sciences et la technologie : notre avenir en dépend

Transforming Science And Technology: Our Future Depends On It

Volume 2
Les Soumissions à la septième conférence internationale sur l'équité des sexes en sciences et en technologie

du 31 juillet au 5 août 1993

Volume 2
Contributions to the Seventh International Gender and Science and Technology Conference

July 31 – August 5, 1993

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587

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588

PREFACE

This book is Volume II of an edited two volume set of papers produced for the seventh International GASAT (Gender and Science and Technology) Conference, held July 31 to August 5, 1993 at the University of Waterloo in Waterloo, Ontario, Canada. The title of the contributions is taken from the conference theme, *Transforming Science & Technology: Our Future Depends On It*. Abstracts of all papers and other presentations have been translated and are published in both English and French. Papers are published in the language in which they were submitted (English or French).

GASAT provides a forum for individuals and organizations concerned about the inclusion of girls and women in the world of science and technology, from early childhood to work environments. Previous conferences have been a contributing force in the advancement of knowledge, understanding and program development on the issue of gender and science and technology. Past international conferences have been held in Eindhoven, The Netherlands (1981); Oslo, Norway (1983); London, U.K. (1985); Ann Arbor, U.S.A. (1987); Haifa, Israel (1989) and Melbourne, Australia (1991).

The GASAT Association is concerned with issues arising from interactions between gender and science and technology. Its objectives are:

- to encourage research into all aspects of gender differentiation in science and technology education and employment;
- to foster gender equity in science and technology, in education and in the workplace;
- to facilitate the entry of women into employment in the fields of science and technology, and their progress within such employment;
- to foster socially responsible and gender-inclusive science and technology;
- to provide a forum for dissemination and discussion of research findings and experiences of those working in the field;
- to provide a support network for those working towards the objectives outlined above.

Over 150 contributions from some 20 different countries spanning six continents are represented in these two volumes, with papers, symposia, workshops and round tables addressing the four aspects of activity in the field of gender and science and technology:

- Current Innovative Intervention Projects
- Research Findings
- Evaluative Syntheses of Interventions
- Critical Research Reviews

Additional sessions may be added to the agenda of GASAT 7. For further descriptions see *Volume III, Proceedings* October 1993. These contributions bring together perspectives, initiatives and ideas which are at the forefront of world-wide activity in the area of gender and science and technology. We anticipate that the research and experiences presented in these volumes will expand horizons and stimulate further thinking in the area.

Sharon Haggerty **Ann Holmes** **Mary Beam**

INTRODUCTION

Ce livre est le volume II d'une série de deux volumes de documents de recherche créés pour la septième conférence biennale sur l'équité des sexes en sciences et en technologie (GASAT -- Gender and Science and Technology), qui se tiendra du 31 juillet au 5 août 1993 à l'Université de Waterloo, Waterloo, Ontario (Canada). Le titre des soumissions est repris du thème de la conférence, *Transformer les sciences et la technologie : notre avenir en dépend*. Les sommaires de tous ces documents et des autres présentations ont été traduits et sont publiés en français et en anglais. Les documents de recherche sont publiés dans la langue choisie par l'auteure ou auteur (français ou anglais).

La GASAT sert de tribune aux personnes et organismes qui oeuvrent pour que les jeunes filles et les femmes participent activement aux sciences et à la technologie, de la petite enfance au milieu de travail. Les six conférences précédentes ont joué un rôle important en favorisant le développement des connaissances et l'élaboration de programmes dans le domaine de l'équité des sexes en sciences et en technologie. Les conférences internationales précédentes ont eu lieu à Eindhoven, Pays-Bas (1981); à Oslo, Norvège (1983); à Londres, Grande-Bretagne (1985); à Ann Arbor, États-Unis (1987); à Haïfa, Israël (1989); et à Melbourne, Australie (1991).

L'Association GASAT s'intéresse vivement aux questions que soulève l'interaction des sexes, des sciences et de la technologie. Ses objectifs sont les suivants :

- favoriser la recherche portant sur toutes les questions relatives à l'inégalité des sexes dans les domaines des sciences et de la technologie, à l'école comme au travail;
- promouvoir l'équité des sexes en sciences et en technologie, à l'école et en milieu de travail;
- encourager les femmes à faire carrière en sciences et en technologie et les aider à progresser dans ces domaines;
- préconiser la responsabilité collective et individuelle ainsi que l'équité des sexes en sciences et en technologie;
- servir de tribune de diffusion et de discussion des travaux de recherches et des expériences des personnes qui oeuvrent dans ces domaines;
- fournir un réseau de soutien aux personnes et organismes qui cherchent à réaliser les objectifs indiqués ci-dessus.

Plus de 150 soumissions de 20 pays des six continents sont présentées dans ces deux volumes. Elles représentent des rapports de recherche, des symposiums, des ateliers et des tables rondes adressant les quatre sous-thèmes du programme sur les sexes et les sciences et la technologie :

- Projets d'intervention novateurs courants
- Recherches
- Synthèses d'intervention
- Analyses critiques de la recherche

D'autres séances peuvent être ajoutées à l'ordre du jour de la conférence GASAT. Pour d'autres descriptions, voir *Volume III, Les Actes de la conférence*, October 1993.

Ces soumissions réunissent les points de vue, les initiatives et les idées à l'avant-garde des efforts mondiaux dans le domaine des sexes et des sciences et de la technologie. Nous espérons que la recherche et les expériences présentées dans ces volumes élargiront les horizons et stimuleront la réflexion dans ce domaine.

Sharon Haggerty **Ann Holmes** **Mary Beam**

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Much appreciation is expressed for the patronage of the Ontario Ministry of Education and Training and the Social Sciences and Humanities Research Council of Canada. Nous tenons à remercier le ministère de l'Éducation et de la Formation de l'Ontario, ainsi que le Conseil de recherches en sciences humaines du Canada pour leur soutien financier.

We would also like to thank the following organizations and companies for their support/Également nous voulons remercier les organismes et compagnies suivants pour leur participation financière:

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We warmly thank the staff of the Ontario Women's Directorate for their support and cooperation in the achievement of the conference. Nous remercions chaleureusement les employées de la Direction générale de la condition féminine de l'Ontario pour leur soutien et collaboration au succès de la conférence.

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594

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595

ORGANIZATION OF THE CONTRIBUTIONS

Contributions are organized by format, level of focus, and finally by activity theme. *Volume I* includes the contributions which are concerned with schooling, including early childhood and those related to the workplace. *Volume II* includes all other contributions. Each volume is organized into four major categories, based on the format of the presentations: papers, symposia, workshops and round table.

Papers are published first, followed by abstracts of the symposia, round tables and workshops, in that order. In *Volume I*, Education and the Workplace are each placed in separate sections; in *Volume II*, Post-Secondary Education and Living in a World Community are also separated. These sections are further divided into sub-sections which reflect the four sub-themes of activities in the field of gender and science and technology: intervention projects, research reports, syntheses of interventions and critical research reviews.

Within each of these sections, papers and abstracts are organized alphabetically by the first author's name. For ease of identification and cross-referencing, a separate alphabetical index of all authors is also provided.

L'ORGANISATION DES SOUMISSIONS

Les soumissions sont divisées selon le thème, l'optique choisi et la forme. Le *volume I* comprend les soumissions qui sont reliées à l'éducation, de la petite enfance jusqu'au milieu de travail, et le *volume II* comprend tous les autres soumissions. Chaque volume est divisé en quatre catégories principales, selon la forme des présentations : rapports de recherche, symposiums, tables rondes et ateliers.

Les rapports de recherche apparaissent en premier, suivis des résumés des symposiums, des tables rondes et enfin des ateliers. Le *volume I* est divisé en deux sections: éducation et milieu de travail et dans le *volume II*, on retrouve enseignement postsecondaire et la vie dans une collectivité mondiale. Chacune de ces sections sont divisées en sous-sections, qui reflètent les quatre sous-thèmes du programme sur les sexes et les sciences et la technologie : projets d'intervention, recherches, synthèses d'interventions et analyses critiques de la recherche.

Dans ces sous-sections, les documents de recherche sont classés par ordre alphabétique (nom de la première auteure ou du premier auteur). Pour faciliter l'identification et la concordance, un index alphabétique séparé de toutes les auteures et tous les auteurs est également fourni.

TABLE OF CONTENTS/TABLE DES MATIERES

VOLUME II

PAPERS/RAPPORTS DE RECHERCHES

Page

POST-SECONDARY EDUCATION/EDUCATION POST-SECONDAIRE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Margaret Bearlin. Australia.
Transforming Primary Science Teacher Education: A Longitudinal Study 559

Suzanne G. Brainard. USA.
A Successful National Women in Engineering Initiative 569

Marcia Braundy. Canada.
Out of the Stream and Into the River: Exploratory Courses in Trades and Technology for Women 579

Hilda Ching. Canada.
Women in Science in Eastern Indonesia Universities 589

Wendy Cukier. Canada.
Equity Curriculum for Engineering Students: A Pilot Project 591

Sally M. Cumming and Martha L. Hendriks. Canada.
Recruiting Females into Physical Science and Engineering Programs at the University Level: A Literature Survey 601

Anne Innis Dagg. Canada.
Making Biology More Humane 611

Sarah J. Dench and Karen B. Levine. Canada.
Mentoring for Women in Engineering: A Case Study 613

Debra A. Desrochers, Jerald M. Henderson and Karen A. McDonald. USA.
Building the Confidence of Women Engineering Students: A New Course to Increase Understanding of Physical Devices 621

Patsy Ann Giese. USA.
Helping Teachers Maximize the Learning of Female Students 631

Catherine Gillbert. Canada.
An Experiment in Female Friendly Chemistry 641

Jeanette Learmont and Jennifer Lindley. Australia.
Beyond Beginnings: An Australian Perspective 651

Sue V. Lewis. Australia.
Including Gender in Higher Education Science and Engineering Courses 661

Paul M. Nyambala. Kenya.
Towards Balanced Gender Partnership in Technical Education 671

Joan Scott. Canada.
Setting Up a Women and Science Course: Process and Content 681

2. Research Findings/Recherches

Abdulrahman S. Attiyat. Jordan.
Strategies for Securing Access of Girls in Science 683

Alison Baignée. Canada.
Attraction and Retention of Women in Engineering - Undergraduate Survey of Engineering Students at the Universities of Ottawa and Manitoba 691

Indira Chacko. Nigeria.
Factors Influencing Undergraduates' Choice of Area of Specialisation at a Nigerian University 701

Olive Chapman. Canada
Women's Ways of Knowing in Mathematics 711

Cinda-Sue Davis and Carol Hollenshead. USA.
Marian Sarah Parker Scholars: A Pipeline Program for Undergraduate Women in Engineering 721

Fran Davis and Arlene Steiger. Canada.
Feminist Pedagogy in the Physical Sciences: A Research Report 730

Rina Doron. Israel.
Encouraging Women to Become Technological Teachers 740

Katherine H. Downey. Canada.
Three Women's Experiences in Construction Apprenticeships 750

Alan Durndell, Helen Watt and Pauline Lightbody. UK.
Gender and Computing: Changes over Time in Scotland 760

Kirsten Gonbaeu Hansen. Denmark.
Gender and Mathematics in Vocational Training and Education 770

Elizabeth Hegarty-Hazel, Peter Logan and Patricia Gallagher. Australia
Gender and Assessment of Students in Physics 772

Carol Hollenshead and Cinda-Sue Davis. USA.
Women in Mathematics and Physics: Inhibitors and Enhancers 782

Anette Kolmos. Denmark.
Reflecting Research Subjectivity in the Room of Sociology and Engineering 792

Jean Denby Manis. USA.
Satisfaction with the Graduate Experience: Student Perceptions of the Academic Climate 802

B. Regina Papa. India.
Female Science Rankholders in Post-Graduate Courses and Career Choices: an Indian Experience 812

Anne-Marie Scholer. USA.
Educational Histories of a Selected Group of Female Academic Biologists 822

Gilda Segal and Mark Cosgrove. Australia.
Developing an Inclusive Technoscience Learning Environment 832

Barbara E. Simpson. USA.
Competition as a Marker for Success in Science 842

Jillian Spink. UK.
Tracking the Aspirations and Achievements of Able Female Students in a Discrete Urban Area 852

Suzanne Wilkinson. UK.
Attitudes to Employment of Female and Male Civil Engineering Students 862

Lynette Willoughby and Ruth Carter. UK.
Electronics Education for Women: Evolving New Approaches 864

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Sylvia Benckert and Else-Marie Staberg. Sweden.
Feminist Critiques of Science and Technology in Engineering Educations: Challenges and Possibilities 874

Karin Beyer. Denmark.
Gender, Project Work and the Meta-Perspectives of Science and Learning 883

Louis Foy. Canada.
L'Intégration des Étudiantes à la Faculté des Sciences et de Génie de l'Université Laval: Bilan et Perspective 893

Barbara Hodgson. U.K.
Opening Science and Technology 901

LIVING IN A WORLD COMMUNITY/VISION GLOBALE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Kis Bonde. Denmark.
Constructing World Pictures 903

Marielle Dufresne. Canada.
Les Femmes Doivent Faire Leur Place Dans le Génie 910

Monique Frize. Canada.
Women in Engineering in Canada: A National Perspective 920

Colin Hocking. Australia.
Including Men in Gender-Inclusive Developments and Practices: Potentials and Dilemmas 930

AnnMarie Israelsson. Sweden.
A Science Center to Serve the Missing Half 940

Victoria A. Kazinja. Tanzania.
Creating a More Inviting Climate and Developing Strategies for Change 950

Francoise Marchand, Manon Côté et Michel Galopin. Canada.
L'Ingénierie Pour les Femmes 952

Jane N. Mulemwa. Uganda.
Uganda's Efforts to Increase Girls'/Women's Participation in STM 962

Jayantee Naugah. Mauritius.
Developing a Feminist Perspective on Science that Recognises the Diversity of Experiences of Women, Girls and Indigenous People 971

Eunice Okeke. Nigeria.
Transforming Society Through Science and Technology: The Case of Rural Women 978

Lionel W.F. Rudd and Georgette Mitchell. Canada.
Engineering Awareness for Grade Eight Students 980

600

2. Research Findings/Recherches

Jeanne Inch, Carol Paschal and Lyne Leclerc. Canada.
Measuring Progress for Women in Engineering, Science and Technology - Applying Benchmarking to Human Resources 990

Ken Moffatt. Canada.
The Influence of Women upon the Definition of a Scientific Knowledge Base for the Profession of Social Work 1000

Lesley H. Parker and Léonie J. Rennie. Australia.
Towards Gender-Fair Assessment in Science I: The Process of the Research 1010

Sharon Parsons. USA.
The History of Feminist Theory as a Basis for Review of the Gender and Science Question 1020

Léonie J. Rennie and Lesley H. Parker. Australia.
Towards Gender-Fair Assessment in Science II: The Initial Outcomes of the Research 1030

Dorothy R. Tovell and Helen M. Madill. Canada.
So What Did You Do With Your Science Degree? A Preliminary Study of Career Patterns 1040

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Kathy Banks. Australia.
The Intractability of Gender Segmentation in the Workplace in Australia 1050

4. Critical Research Review/Analyse critique de la recherche

Silvia Chavarria. Costa Rica.
Gender Biased Mathematics 1060

Valerie S. Norten. Canada.
Women and Engineering 1070

SYMPOSIA/COLLOQUES

POST-SECONDARY EDUCATION/EDUCATION POST-SECONDAIRE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Marcia Braundy. Canada.
Recruitment and Retention Initiatives for Women in Technical Fields 1072

601

Linda Skidmore, Marsha Lakes Matyas, Ruth A. Fowler, Esther M. Conwell, and Mildred S. Dresselhaus. USA.
Recruitment and Retention of Women in Science, Engineering and Technology. 1074

LIVING IN A WORLD COMMUNITY/VISION GLOBALE

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Lesley Parker (Australia), Rosy Agholar (Nigeria), Bev Farmer (New Zealand), Sharon Haggerty and Ann Holmes (Canada).
The Emergence of GASAT Awareness in Australia, Canada, New Zealand and Nigeria: Comparisons and Contrasts 1076

4. Critical Research Review/Analyse critique de la recherche

Rosalind Cairncross. Canada.
Reconnecting Science: Thoughts for a New Model 1078

L.E. Dyck, K. Green, T. MacNeil and J. Schmitz. Canada.
If Women Ran Science... 1080

ROUND TABLES/TABLES RONDES

POST-SECONDARY EDUCATION/EDUCATION POST-SECONDAIRE

2. Research Findings/Recherches

Sheila Tobias. USA.
The "Second-Tier" Analysis 1082

LIVING IN A WORLD COMMUNITY/VISION GLOBALE

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Kathy Browning. Canada.
Design and Technology 1084

Caroline Godin and Josée Lafrenière. Canada.
Les Femmes en Génie ... 1086

602

WORKSHOPS/ATELIERS

LIVING IN A WORLD COMMUNITY/VISION GLOBALE

1. Innovative Intervention Projects/Projets d'intervention novateurs

Jan Harding. U.K.
Empowering Women in Science 1088

Colin Hocking. Australia.
Including Men In Gender-Inclusive Science 1090

Nancy Moore. Canada.
Technology in the Classroom 1092

3. Evaluative Syntheses of Interventions/Synthèses d'intervention

Karen Sturgeon and Peggy Tripp-Knowles. USA and Canada.
Integrating Ethics into Science Classes at the University Level 1094

INDEX

Abramowitz, Fran 529
Acker, Sandra 308
Afolami, C.A. 378
Agholor, Rosy 1, 1076
Ahola-Sidaway, Janice 469
Allard, Andrea 254, 495
Allen, Nessy 407
Amarteifio, Joan O. 177
Anderson, Debra 527
Anderson, Mary R. 417
Armour, Nan 509
Ato, Tortiv 187
Attiyat, Abdulrahman S. 683
Avril, Shirley 515
Baignée, Alison 691
Baker, Tracy 138
Banks, Kathy 1050
Bazler, Judith A 10, 20
Bearlin, Margaret 559
Beauchamp, Shelly 519
Bell, Beverley 358
Belling, Erica 29
Benckert, Sylvia 874
Bernhard, Judith K. 328
Beyer, Karin 883
Biedermann, Julia 29
Bonde, Kis 903
Booker, Mari 68
Brainard, Suzanne G. 569
Braundy, Marcia 579, 1072
Brown, Susan M. 501
Browning, Kathy 1084
Bruzga, Sandra 532
Cairncross, Rosalind 1078
Carter, Ruth 864
Castor, Richard 439
Chacko, Indira 701
Champion, Ron 493
Chandra, Dinesh 197
Chandrasekhar, Kamala 39
Chapman, Olive 711
Chavarria, Silvia 1060
Chetcuti, Deborah A. 207
Ching, Hilda 589
Clarke, Jan 505, 545
Clarke, Valerie A. 46, 158
Collier, Charlotte 20
Collins, Janet V. 138
Conwell, Esther M. 1074
Cook, Nancy 489
Cosgrove, Mark 832
Côté, Manon 952
Crutzen, Cecile K. 459, 503
Cukier, Wendy 591
Cumming, Sally M. 601
Cumo, Joseph M. 217
Dagg, Anne Innis 611
Dahms, Mona 525
Dalton, Jane 505, 545
Davis, Fran 730
Davis, Cinda-Sue 489, 721, 782
De La Torre, Blanca 288
DeLauter, Catherine 288
Dench, Sarah J. 613
Deschamps, Isabelle 479
Desrochers, Debra A. 621
Dick, Bev 533
Dickson, Marilyn 387
Dogger, Norma 387
Doron, Rina 740
Downey, Katherine H. 750
Dresselhaus, Mildred S. 1074
Dufresne, Marielle 910
Durndell, Alan 760
Dyck, Lillian E. 1080
Emms, Judy 318
Evans, Mary Anne 489
Eyre, Linda 225
Farmer, Bev 1076
Fletcher, Debra 29
Fowler, Ruth A. 1074
Foy, Louis 893
Frantz, Sharon 235
Frantzve, Jerri L. 439
Frize, Monique 920
Gallagher, Patricia 772
Galopin, Michel 952
Gaskell, Jim 244

Geddis, Arthur N. 97
Giese, Patsy Ann 631
Gilbert, Jane 358
Gillbert, Catherine 641
Godin, Caroline 1086
Gonbaeu Hansen, Kirsten 770
Greed, Clara H. 419
Green, K. 1080
Haggerty, Sharon 1076
Hall, Wendy 68
Hansen, Karen 535
Harding, Jan 1088
Hayes, Debra 499
Hegarty-Hazel, Elizabeth 772
Henderson, Jerald M. 621
Hendriks, Martha L. 601
Hennessy, Sara 118
Hildebrand, Gaell 254, 495
Hill, Christine 537
Hiscocks, Peter D. 56
Hocking, Colin 930, 1090
Hodgson, Barbara 901
Hoffman, Lore 66
Hollenshead, Carol 721, 782
Holmes, Ann 1076
Hulme, Marylin A. 547
Ighoroje, Ahbor Dolly A. 429
Inch, Jeanne 990
Israelsson, AnnMarie 940
Johnston, Valerie C. 539
Jones, Mabel 557
Joslyn, Lynne 541
Kazinja, Victoria A. 950
Kirkup, Gill 318
Kolmos, Anette 792
Koontz, Trish Yourst 264
Kristjanson, Cheryl 543
Lafrenière, Josée 1086
Lancaster, Ron 519
Leclerc, Lyne 990
Learmont, Jeanette 651
Leek, Barb 505, 545
Levine, Karen B. 613
Lewis, Sue V. 661
Lightbody, Pauline 760
Lindley, Jennifer 651
Lips, Hilary M. 439
Logan, Peter 772
Lovegrove, Gillian 68
Lubetkin, Rebecca L. 547
Lyne, Marion L. 158
MacNeill, T. 1080
Madill, Helen M. 1040
Mallow, Jeffry V. 78
Man in't Veld, Magda 274
Manis, Jean Denby 802
Mappen, Ellen 489
Marchand, Francoise 952
Matyas, Marsh Lakes 1074
Mays, Janet 549
McClintock Collective 551, 553
McDonald, Karen A. 621
McKinley, Elizabeth 358
McKinnon, Margaret 469
McLean, Lois 507
Mitchell, Georgette 980
Moffatt, Ken 1000
Moore, Nancy 1092
Morin, Josée 521
Mulemwa, Jane N. 513, 962
Mullins Gunst, Kerrie 491
Murphy, Patricia 276
Naugah, Jayantee 971
Nicoll, Elinor 509
Nordhus, Lillebit 523
Norlen, Valerie 1070
Nyambala, Paul M. 671
Nyhof-Young, Joyce 328
Oatley, Keith 308
O'Connell-Ganges, Elizabeth 489
Okeke, Eunice 978
O'Shea, Tim 118
Otrupcek, Robina 88
Pack, Brian 439
Papa, B. Regina 812
Parker, Lesley H. 1010, 1030, 1076
Parsons, Sharon 288, 1020
Paschal, Carol 990
Pieterson, Carla 97
Raghuwanshi, Chandralekha 107
Rennie, Léonie J. 1010, 1030
Robertson, Heather-Jane 368
Rom, Yael 397
Rudd, Lionel W. F. 980
Ryan, Heather 298
Ryan, Jacqui 533

605

Sanders, Jo	109
Scanlon, Eileen	118
Schmitz, Jan	1080
Scholer, Anne-Marie	822
Scott, Joan	681
Segal, Gilda	832
Selleck, Laura J.	338, 497
Sharma, Archana	197
Sharp, Annette	511
Sheasby, Marjorie	138
Sherriff, Barbara L.	128
Simonis, Doris G.	217
Simpson, Barbara E.	842
Skidmore, Linda	1074
Smith, Walter S.	491, 555
Smith, Gillian	449
Smyth, Elizabeth	493
Sørensen, Helene	348
Spink, Jillian	852
Spokane, Arnold R.	20
Staberg, Else-Marie	499, 874
Steiger, Arlene	730
Stig, Benthe	523
Sturgeon, Karen	1094
Sullivan, Kathleen	489
Surry, Jean	138
Tarr, Karen E.	148
Taylor, Josie	118
Teague, G. Joy	46, 158
Tel, Shadia A.	168
Tessman, Richard	507
Tobias, Sheila	1082
Tovell, Dorothy R.	1040
Tripp-Knowles, Peggy	531, 1094
Volman, Monique	499
Volpe, Rosemarie	549
Wall, Tami	527
Walton, Anne	449
Warren, Catharine	235
Watt, Helen	760
Webber, Vicky	499
Whitelock, Denise	118
Williams, Stella	517
Willoughby, Lynette	864
Wilkinson, Suzanne	862
Wilson, Karen	439
Wubbels, Theo	274
Wynings, Christina	439

606

TRANSFORMING PRIMARY SCIENCE TEACHER EDUCATION – A LONGITUDINAL STUDY

Margaret L. Bearlin

En 1989, l'Université de Canberra a mis sur pied un projet appelé PECSTEP (Primary and Early Childhood Science and Technology Education Project). Ce projet avait pour but d'améliorer la formation disponible au personnel enseignant dans le domaine des sciences, tant la formation préalable que la formation en cours d'emploi, ainsi que celle des étudiantes des écoles primaires et préscolaires. Depuis, plus de 200 enseignantes se sont jointes au programme de formation en cours d'emploi du projet PECSTEP. D'une durée d'un an, le programme prévoit des ateliers pendant le premier semestre et le développement et l'évaluation du programme d'études scolaires pendant le deuxième semestre. Faisant appel à une approche interactive et tenant compte des sexes, ce programme débute avec un cours de technologie ménagère permettant aux enseignantes, dans une ambiance coopérative et non menaçante, de développer et d'examiner leurs propres questions et de partager leurs conclusions avec leurs collègues. Après examen de leur propre processus d'apprentissage, les enseignantes ont recours à la même procédure pour développer, enseigner et évaluer un module d'études au sein de leurs propres salles de classe. À la fin du programme, les enseignantes montraient un intérêt accru à l'égard de l'enseignement des sciences et de la technologie, elles avaient l'impression d'être plus compétentes dans l'enseignement de ces matières et avaient acquis une perception nouvelle relativement aux réactions des filles et des garçons face à l'enseignement des sciences. Ce document fait le compte rendu d'une étude de suivi sur les enseignantes du premier groupe en formation en cours d'emploi un an après la fin du programme. On a découvert que les niveaux accrus d'intérêt et de confiance envers l'enseignement des sciences et de la technologie avaient été maintenus. Les données d'entrevues ont également permis d'en apprendre davantage sur les perceptions du personnel enseignant des effets à long terme les plus importants du programme.

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TRANSFORMING PRIMARY SCIENCE TEACHER EDUCATION - A LONGITUDINAL STUDY

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ABSTRACT

In 1989 PECSTEP (The Primary and Early Childhood Science and Technology Education Project) was established at the University of Canberra in an attempt to improve the science education available to female teachers, both preservice and inservice, and to female students in primary and preschools. Since then over 200 teachers have undertaken the inservice program that forms the core of the Project. A year long program, it consists of workshops in first semester and school based curriculum development and evaluation in second semester. Using a gender-sensitive, interactive approach it begins with household technology enabling teachers in a supportive, non-threatening situation to develop and investigate their own questions, and to share their findings with their peers. After reflecting on the process of their own learning teachers use the same procedure to develop, teach and evaluate a curriculum module in their own classrooms. By the end of the program teachers have consistently reported increased levels of interest in teaching science and technology, an increased sense of competence in teaching in these areas, and changed perceptions of girls' and boys' responses to their science teaching. This paper reports on a follow up study of teachers in the first inservice cohort one year after they had completed the program. There is evidence that increased levels of interest and confidence in teaching science and technology have been maintained. Interview data also gives insight into teachers' perceptions of the most important lasting effects of the program.

CONTEXT

The Primary and Early Childhood Science and Technology Education Project (PECSTEP) was initiated in 1989 in the context of increasing concern about general standards of scientific and technological literacy and expertise in Australia, a setting in which girls had been identified on grounds of both equity and utility, as needing special attention. To overcome their under-representation in science beyond the compulsory level, and their low self-confidence especially in the physical sciences, both curriculum reform and improvement in teacher education at all levels had been recommended. (*National policy for the Education of Girls in Australian Schools* 1987: Dawkins, 1987).

Purpose of the Project

The PECSTEP project is directed at the primary and early childhood levels of teacher education because children's attitudes to science are formed at this time, if not earlier. It involves both men and women, but is especially concerned with women because female teachers predominate in primary schools, and tend both to have more negative perceptions of their teaching skills in the physical sciences than males, and to expect girls to perform less well in these areas than boys, with likely serious consequences for the girls. (Parker, 1987). Government reports, using liberal humanist discourse had sited the problem in women. They assert that if we want girls, in primary schools, both to be taught science and to develop positive attitudes to it, it is crucial that women teachers become more confident and competent in science, and aware of the way in which their attitudes and expectations are communicated to girls. Feminist philosophers and educators, on the other hand, argue that such analysis is flawed in its account of gender and will lead to unproductive strategies (Kenway and Willis, 1991). If science and technology education are to be empowering experiences for women and girls we need to look not only at the attitudes of women but also at the nature of science and technology as they have encountered and will encounter them. PECSTEP thus can be said, in liberal humanist language, to be directed at identifying science teacher education practices successful "in changing the attitude of (women) primary and early childhood teachers to science" or, in the more theoretically powerful discourse of critical/feminist theory, "to seek to enable women primary and early childhood teachers to encounter science and technology in a way that enables them to lose their self-limiting beliefs and become empowered and empowering science and technology educators for all girls and all boys."

Theoretical basis

The PECSTEP inservice program was designed to be explicitly and coherently gender sensitive · It was based on a "knowledge and person-centred" model of teacher education (Bearlin, et al 1990) which brings together two major bodies of theory: constructivism in science education, and feminist philosophical critiques of science and human action.

Constructivist theorists (Driver, 1989) emphasise the activity of the learner or knower in the construction of meaning or knowledge, and the importance of teachers, of any kind, taking seriously the consciousness of the learner: what the learner already knows, the way she or he sees the world, and using the learner's own questions as the starting point for the acquiring of

scientific understanding. Scientific knowledge is thus seen as humanly constructed. However little emphasis seems to be placed on the social and political nature of the construction of scientific knowledge (scientist's science) at least from a gender perspective.[2]

In contrast those feminist theorists who see gender relations as power relations emphasise the social, and hence gendered, construction of both persons and knowledge. (Lather, 1991). Both persons and knowledge are seen as constructed and hence gendered (as also affected by class and ethnicity power relations). In common with (science education) constructivists, these theorists see humans - women and men, boys and girls - as active in their own construction of meaning, but in a broader sense. They are active both in their construction of scientific understanding and in their own gender construction. From this perspective human thought and action are seen as dichotomised, split into bipolar opposites: mind/body, reason/emotion, objectivity/subjectivity, active/passive culture/nature. The active, powerful (power over) modes being designated male/masculine, the less active, less powerful and less publicly-valued modes, female/feminine. The more **separated** the modes of thinking and acting are from the concrete, living reality of human life, the more masculine they are considered; the more **connected**, the more feminine. (Fee, 1981, Harding, 1986) The claim that science is the paradigm of objective, rational thought, simultaneously positions it as paradigmatically masculine. As Keller (1985) has argued, dominant science (scientist's science) and gender in western culture can be seen to be **interdependently** constructed.

Thus, as girls attempt to understand the world in a scientific way, or to engage in the practices that give them access to those understandings, they encounter hostility from boys and teachers, and conflict in learning appropriately gendered behaviour. (Clark, 1989; Davies, 1989; Walkerdine, 1987). As they encounter science and technology they learn that activities that make for success in science are not considered appropriate for girls. The study of the physical and technological world of inanimate objects and machines is gendered male. The nurturing of people and living things is gendered female. Science and technology identified with the female/feminine is devalued or made invisible (Stanley, 1983).

Program Structure and Teaching Approach

Dr Valda Kirkwood, an experienced science educator and researcher developed and taught the year-long inservice program. She chose to role model an interactive, constructivist teaching approach, as developed at the University of Waikato, but with her own gender-sensitive

interpretation. Explicit work on gender was included for metacognitive purposes. This was seen as crucial if teachers were to understand how they had acquired their self-limiting beliefs and so not replicate the experience for girls in their care, constructing instead empowering learning experiences for both girls and boys.[3]

The program consisted of 14 two-hour workshops in semester 1. In semester 2 the teachers developed, taught and evaluated a curriculum unit of their own choice based on the understandings of semester 1 and with the support of the tutor and regional network groups. In 1989, three groups of primary and early childhood teachers (60 women and 10 men) undertook this course, in their own time, approximately one third taking the unit for credit, either upgrading to a B.Ed or doing a Masters' Course.

After sharing over a cup of tea their anxieties and expectations for the program, the teachers' began a series of workshops on toasters (chosen because of difficulties many teachers face in teaching about electricity). They began by writing down everything they knew and felt about toasters and what they would like to know. They then set about investigating their own questions (e.g. how does a toaster really work?) by taking toasters apart, setting up electrical circuits etc. Teachers worked in small groups of their own choice (or individually) for both practical work and discussion and came together as a whole for sharing sessions e.g. on their findings and to reflect on the teaching - learning approach as they were experiencing it. A second curriculum unit on bread began with a bread-making session followed by sessions in which teachers investigated questions arising for them about such things as the biological aspects of yeast and the dangers of food additives. Readings of papers/books were sometimes set. Teachers also carried out action research in their own classrooms on gender differences in children's question asking and answering, use of equipment and choice of careers. During this program teachers kept diaries to record their own learnings and to reflect on the many questions, which surfaced and were discussed, relating to their understanding of teaching, learning, science, technology, knowledge and classroom interaction. During the second semester while developing, teaching and writing up curriculum units based on the same gender - sensitive, interactive principles, teachers met in network groups supported by the tutor.

Evaluation of the Program 1989 and 1990 follow up study.

The response of teachers to the inservice program indicate its success in providing teachers with empowering learning experiences in science and technology education. Surveys, case study interviews, diary keeping and the quality of the curriculum units developed by the teachers provided systematic data on its effectiveness.

Surveys were completed pre-course, mid-course and post-course during 1989 and in 1990 one year after completion of the course. Teachers were asked about their level of interest, current background knowledge and teaching competence in science and technology, and the importance of teaching science and technology to young children. They were asked to indicate their perceptions of girls' and boys' responses to science teaching and learning. The surveys in 1989 also asked teachers about their background in science, their experiences in teaching and learning science, and their understandings of science, technology, teaching, learning, knowledge and gender. 4

The follow-up survey replicated the quantitative questions in the 1989 surveys and also asked teachers to share insights, both thoughts and feelings about their teaching in science and technology, their use of an interactive approach, aspects of the program they considered most effective and of lasting benefit, and any changes in their professional and personal lives flowing from their participation in it. These questions were pursued further with five of the case study teachers who were also videoed teaching science in their classrooms and their responses on viewing these videotapes recorded. Forty teachers completed the 1989 post course survey, 20 the November 1990 follow- up survey. 5

Findings

In a paper of this length it is possible only to give a summary of the quantitative data from the 1989 post-course and 1990 follow-up surveys and selections from the 1990 qualitative data.

(i) Significant differences were found in the 1989 pre-course and post-course surveys in interest in teaching science, in teaching technology, and in teaching the specific science areas of 'life', 'energy,' 'matter', 'earth' and 'space'. All of these changes in attitudes were maintained in 1990 except for teaching about 'earth'.

(ii) There was a significant positive change in teachers' perceptions of the adequacy of the level of their background knowledge for teaching both science and technology. This was maintained in 1990 in all areas.

(iii) The significant change in sense of competence in teaching both science and technology attained by the end of the program was maintained a year later. In both cases teachers felt more competent teaching science than technology.

(iv) Changes in perceived level of interest and involvement of girls and boys in science. As the inservice program progressed teachers indicated significant changes in their perceptions of girls' behaviour. They saw girls, but not boys, as more likely than before to be interested in science and to involve themselves in science lessons, to ask questions, to investigate to find answers, to tinker or play around with equipment and to use their heads to sort things out before using equipment. Girls were seen initially by teachers as less likely than boys to be engaged in all of these activities. All of these changes in perception were maintained with the exception of girls' tinkering. Girls were seen as less likely to tinker a year later.

Teachers' perceptions of girls' ability to communicate in groups and to work cooperatively, initially higher than for boys, increased significantly during the program and this change in perception of girls' behaviour was maintained. The only change in perception of boys' behaviour related to their ability to work cooperatively. This increased significantly and the increase was maintained a year later.

Overall the follow-up surveys indicate that the increases in teachers' interest in teaching science and technology, and in their sense of their own competence and the adequacy of their own background knowledge for the task have been maintained a year later. This is strongly borne out in the qualitative data. Likewise the changes in teachers' perceptions of what is happening in their classrooms, in particular their increased expectations of girls, have also been maintained.

In the follow-up surveys and interviews all teachers still in classrooms (several, empowered by the experience of the program, had moved into administrative positions) were attempting to teach science and technology often with little support but with considerable enthusiasm and delight at the outcomes. All were using an interactive approach in some way. Many had applied insights gained in the inservice

program in other curriculum areas. Many teachers named the experience of an interactive approach and the consequent deepening of understanding of the teaching - learning process as the aspect of the program which was most effective or of lasting benefit to them: "the *most effective part of the course was actually working on the toaster i.e. going through the interactive process myself. The discussions with Valda (the tutor) were vital. I learned about learning which has much wider repercussions on my teaching than science and technology teaching. "(Wendy)*

This teacher also found her concept of science changed: "the *course allowed me to demystify science and technology and bring it into the realm of something I would access".*

The non-threatening, supportive and positive atmosphere of the workshops was also named, together with the development of greater gender-sensitivity: "a *heightened awareness of the gender issues in science education, leading to conscious efforts to overcome the problems as much as possible'.(Jan.)*

Teachers described changes in their professional and personal lives. Many had taken initiatives not thought possible previously - participation in curriculum design panels, presentation of papers and workshops at local and national science teacher conferences. Others were inservicing colleagues in their schools, writing articles for journals, judging science competitions, enrolling for higher degrees. All were not so enthusiastic. One teacher apparently wanting more ready-made curriculum units felt she had gained little from the program.

Discussion

The success of the PECSTEP inservice program in achieving its goals we believe is best accounted for in terms of the sound (implicit) theoretical base, outlined above, which is made explicit in the program. The key factors in this explicitly gender-sensitive interactive teaching approach are discussed elsewhere. (Kirkwood et al 1989). The approach could be characterized as "connected teaching", as Belenky et al (1986) have named it in their study of women's ways of knowing. In this approach deeply respectful of both knowledge and persons, the teacher focuses on her students' knowledge (rather than her own), and on the feelings associated with it enabling

women to understand scientific knowledge (and knowing) as no longer separate from their lives; to see it as something over which they can have control rather than it having power over them. In this way many of the dichotomies in dominant science are transcended. Attitudes to science and self-limiting beliefs about science teaching are changed by changing what science and science teaching and learning are perceived to be and experienced as being (Hardy et al, 1990)

Conclusion

The findings indicate that through participation in an inservice program with an explicitly gender-sensitive, interactive teaching approach, teachers can overcome their often negative views of science and their self-limiting views of themselves as science teachers, and that these changes can be lasting. The extent to which these changes are connected with changed theoretical perspectives and are expressed in effective teaching practice in the classroom are the subjects of our current research.

Footnotes

1. I wish to acknowledge the unique contribution of Valda Kirkwood to the initial development of the PECSTEP Inservice Program and the support and participation of Tim Hardy, Co-director of the Project, and the work of Robin Lendon and Vivien Hehir-Smith as Research Officers.
2. We are referring here to the "constructivist school" in science education in Australia and New Zealand active particularly at Monash and Waikato Universities.
3. This matter of including explicit work on gender had, itself, to be handled with considerable gender-sensitivity (Clark, 1989) and hence.
4. Details of the qualitative survey data for 1989 can be found in Hardy, Bearlin and Kirkwood (1990) and in Kirkwood, Bearlin and Hardy (1989).
5. Using T-tests the means of the cohort of 20 (follow-up survey) and the cohort of 40 (post-course survey) have shown no significant differences with the cohort of 62 (Pre-course survey) on items on the Pre-course survey, with two exceptions. For the purposes of this study the follow-up cohort of 20 is taken as being representative of the initial group.

615

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A SUCCESSFUL NATIONAL WOMEN IN ENGINEERING INITIATIVE

Suzanne G. Brainard, Ph.D.

Au cours des quatre dernières années, l'Initiative WIE (Women in Engineering Initiative) du College of Engineering de l'University of Washington a transformé un important projet en un modèle national visant à assurer la formation adéquate des ingénieures et leur entrée dans ce secteur. Étant donné le souci de la compétitivité technologique des États-Unis dans l'économie globale, des programmes de recrutement et de rétention des étudiantes-ingénieures sont désormais au nombre des priorités des établissements d'enseignement supérieur du pays. Grâce au leadership procuré par l'initiative WIE, les établissements d'enseignement supérieur comprennent désormais comment ils peuvent aider les femmes à réussir dans leurs études et dans les professions de génie.

Après quatre années, l'initiative WIE n'a toujours pas modifié son principal objectif d'accroître la participation et la rétention des femmes dans les études de génie de premier et deuxième cycles. L'initiative WIE met l'accent sur les femmes à tous les niveaux, y compris les étudiantes de première année, les étudiantes des cours préparatoires aux études de génie, les étudiantes au niveau du baccalauréat et les étudiantes de deuxième cycle. Les étudiantes proviennent d'ethnies diverses et beaucoup d'entre elles viennent d'une autre université ou retournent aux études.

En plus de son succès à l'échelon de l'État à accroître la participation des femmes dans les études de génie, l'initiative WIE est l'un des trois «co-fondateurs» du Women in Engineering Program Advocates Network (WEPAN), une association nationale de programmes WIE offrant de l'aide technique aux collèges et universités du pays tout entier pour lancer ou améliorer les programmes à l'intention des étudiantes-ingénieures.

En suivant le développement chronologique et historique de l'initiative WIE, ce document a pour but de : a) traiter d'une série de facteurs critiques qui ont permis le succès de l'initiative WIE; b) décrire les objectifs, le réseau de seize services et programmes et les mécanismes d'évaluation formels; et c) résumer les accomplissements à l'échelon de l'État et du pays de l'initiative WIE.

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617

A SUCCESSFUL NATIONAL WOMEN IN ENGINEERING INITIATIVE

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ABSTRACT

Over the last four years, the Women in Engineering (WIE) Initiative in the College of Engineering, University of Washington, has grown from an important program idea to a significant national model for assuring that women become well-trained engineers and successfully enter the engineering workforce. With growing national concern about the technological competitiveness of the U.S. in the global economy, recruitment and retention programs for female engineering students have become a higher education priority nationwide. Through WIE Initiative's leadership, higher education is understanding how to help women succeed in engineering education and in the engineering workforce.

Now in its fourth year of operation, the primary goal of the WIE Initiative has remained the same: to increase the participation and retention of women in engineering at the undergraduate and graduate levels. WIE focuses on women at all levels, including freshmen, pre-engineering, undergraduate majors, and graduate students. The students are ethnically diverse and many are transfer and returning students.

In addition to its statewide success in increasing the participation of women in engineering, the WIE Initiative is one of three co-founders of the Women in Engineering Program Advocates Network (WEPAN), a national association of Women in Engineering Programs providing technical assistance to colleges and universities across the U.S. to initiate or expand programs for women engineering students.

By tracing the chronological and historical development of the WIE Initiative, the purpose of this paper will be to: a) discuss a series of critical factors that led to the success of the WIE Initiative; b) describe the goals, network of sixteen services and programs, and formal mechanisms of evaluation; and, c) summarize the statewide and national accomplishments of the WIE Initiative.

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INTRODUCTION

As attention has been focused on the future of the nation's technological competitiveness in the global economy, and on the social and moral necessity of achieving equity and parity for women and minorities in science and engineering, we have seen a surge of intervention programs implemented at both the pre-college and university levels. With few exceptions, most of these intervention programs lack stated and measurable objectives, strategic plans, evaluation components, focused programmatic efforts, and, as a result, have low student participation rates.

In an earlier article, I (Brainard, 1989) proposed that a number of prerequisite conditions are critical to insuring the successful implementation of intervention programs, including commitment and support from the top; designated director of the program; reasonable and adequate budget; assistance in fundraising, faculty commitment and involvement; system of accountability; and student ownership in the programs. Further research (Brainard, 1991) has indicated that preparation of strategic plans for implementing intervention programs is critical to success.

Recognizing that there are multiple factors involved in the successful implementation of an intervention program, the importance of student ownership in the WIE Initiative was the key critical success factor (Brainard, 1993) in insuring that the stated objectives of the intervention programs were accomplished. To illustrate this, the chronological and historical development of the Women in Engineering Initiative at the University of Washington is traced.

History

Peters and Waterman (1984) proposed that eight basic principles guide successfully run companies. Three are particularly relevant to the underlying assumptions of the Women in Engineering Initiative: Staying close to the customer -- learning her preferences and catering to them; autonomy and entrepreneurship -- breaking the corporation into small companies and encouraging them to think

independently and competitively; and productivity through people -- creating in all individuals the awareness that their best efforts are essential and that they will share in the rewards of the company's success.

With these basic principles in mind, the Women in Engineering Initiative was established in 1989. Its primary goal was to increase the retention of women in engineering. In its initial planning stages, a student steering committee composed of fifteen undergraduate and graduate students assumed the initial task of designing the ideal organization to meet women engineering students' needs. Using a focus group approach, the committee's first step was to delineate the barriers women face in pursuit of an engineering degree. The Committee members identified the major barriers as isolation, competition, low self-confidence, childbearing and childrearing issues, lack of role models, and insufficient financial assistance. A comprehensive review of the literature indicated that these were common problems of women in nontraditional fields. However, none of the research focused on effective interventions for women in engineering or in other nontraditional fields.

The next step was to propose and design programs that focused on solutions to the identified barriers. Starting small, the steering committee proposed four programs: tutoring, peer mentoring, professional mentoring, and support group meetings. Each of these programs addressed at least two of the barriers previously identified by the students. For example, support group meetings addressed the feelings of isolation, low self-confidence, and childbearing and childrearing issues. Individual members of the committee then decided to break into small groups and take responsibility for individual programs. Students in charge of a program were given the title of chair; for example, chair of mentoring. The purpose of this was to give the students a sense of ownership.

Working with a WIE staff member, each chair takes the lead in designing and implementing a program. Objectives are stated, brochures are designed, marketing strategies are put into place, events scheduled, and evaluation questionnaires are prepared. Early on, it was recognized that the turnover in

student chairs would be high as students moved through their programs and graduated in engineering. To insure the continuity of the WIE Initiative and the individual programs, the process of "grooming" was initiated, and the title of co-chair was added. "Grooming" became the process of training a new student to run a program.

The chair and co-chairs receive recognition for their efforts in numerous ways, including articles about them and their programs in the *WIE Press*, a quarterly newsletter; opportunities to meet individually with the corporate sponsors and corporate and faculty boards; attendance at conferences; presentations at high schools and community colleges; and an additional activity to add to their resume demonstrating leadership and commitment to volunteering.

Bi-monthly steering committee meetings are held to assure a continual flow of information and communication of on-going activities. The chair and co-chair of each program present status reports on their activities. The meetings tend to focus on problem-solving, needs identification, brainstorming new ideas, and planning. A calendar of events is maintained in the study center to alert everyone to upcoming events, allow for reasonable scheduling, and avoid overlapping events.

A synergy occurs. Students exhibit pride in their programs and in turn receive praise for their accomplishments. The energy level is high and follow-through is reliable. Students demonstrate a spirit of team play offering help to other programs when needed. They recognize that the success of the Women in Engineering Initiative as a whole is dependent on the success of each programmatic component. That is, they perceive they are part of a team and, for that team to be successful, they as individuals must be successful. The result is that each person is a star in running her own program, as well as being a member of a winning team.

MISSION AND PROGRAM COMPONENTS

Now in its fourth year of operation, the primary goal of the WIE Initiative has remained the same: to increase the participation and retention of women of all ethnicities in engineering at the undergraduate and graduate levels. WIE focuses on women at all levels, including freshmen, pre-engineering, undergraduate majors, and graduate students. Using a multifaceted approach to reach approximately 700 students annually, WIE's specific objectives are to:

1. Foster an academic and social climate conducive to women and men in engineering by building a collaborative learning community;
2. Deliver programs focused on retention, academics, and study skills;
3. Track female engineering students from the point of entry through career to profile and monitor their progress;
4. Conduct outreach activities to increase the numbers of women recruited and retained in engineering; and,
5. Conduct research on issues of women in engineering and the sciences.

In order to accomplish these objectives, a comprehensive network of programs and services is offered to all female students interested in pursuing an engineering degree.

1. *Mentoring Programs*
   a. *Peer Mentoring*
   b. *Professional Engineering Mentoring*
   c. *Faculty Mentoring Program*
2. *Scholarships and Fellowships*
3. *Tutoring*
4. *Freshmen Intervention Program*
5. *The Women in Engineering Study Center*
6. *Women in Engineering Study Class*
7. *International Exchange*
8. *Support Groups*
9. *Annual Women in Engineering Conference and Seminars*
10. *Summer Outreach Programs to High School Students*
11. *Advising and Counseling*
12. *Publications*
    a. *Newsletter*
    b. *Resource Directory*
    c. *Proceedings of the Women in Engineering Conference*

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ACCOMPLISHMENTS: A LOCAL AND NATIONAL LEADER

LOCAL

Highlights of enrollment and graduation statistics for women in engineering between 1988 and 1992 are outlined below. This four-year span represents the time in which the WIE Initiative has been operational.

- Women earned 17% of the bachelors' degrees in 1988 and 23% of the degrees in 1992.
- Women earned 13% of the masters' degrees in 1988 and 19% in 1992.
- Women earned none of the Ph.D. degrees in 1988 and earned 13% of the Ph.D.'s in 1992.

The results of this year's evaluations by the advisory boards have further indicated a high level of success in the following:

1) Increased participation and graduation rates of women in engineering at the undergraduate and graduate levels since the WIE Initiative began at the University of Washington.
2) Surpassed national trends in enrollment and degrees granted to women in engineering.
3) Increased student participation rates in the WIE Initiative in four years, from 5% to 65% of total women enrolled in engineering.
4) Received two competitive two-year Graduate Fellowships from the Clare Boothe Luce Foundation totaling $100,000.
5) Received a total of five undergraduate scholarships annually from the Weyerhaeuser Company Foundation and the Intel Foundation.
6) Developed an active community of female and male students studying and working together in the Women in Engineering Study Center.
7) Initiated a Freshmen Intervention Program with a grant from the Alfred P. Sloan Foundation, to recruit and retain female freshmen in engineering.
8) Established a Coalition, sponsored by Philip Morris, with the University of Washington and five community colleges to facilitate the transfer of

female students in science and engineering from a two-year to a four-year institution.

9) Held the first Annual WEPAN Western Regional Women in Engineering Conference, sponsored by the Intel Foundation, at the University of Washington drawing more than 250 participants from the 14-state region, including students, faculty and practicing engineers and scientists. The second conference is scheduled for 3 April 1993.

NATIONAL

The WIE Initiative has become a national model. Highlights of the successes of the WIE Initiative as a national leader include:

1) Co-founders of the Women in Engineering Program Advocates Network (WEPAN), a national association of Women in Engineering Programs, funded by the National Science Foundation, providing technical assistance to colleges and universities across the U.S. to initiate or expand programs for women engineering students.

2) Established the WIE Initiative at the University of Washington as the site for the WEPAN Western Regional Center for Women in Engineering by a grant from the National Science Foundation and the AT & T Foundation.

3) The WIE Mentoring Programs were featured as a national model at the 1992 Conference, *Science and Engineering Programs: On Target for Women*, sponsored by the Committee on Women in Science and Engineering of the National Research Council, the operating arm of the National Academy of Science and Engineering.

EVALUATION

Two primary types of evaluation are conducted each year: a) an overall evaluation of WIE's effectiveness and impact; and, b) an assessment of the programmatic components, such as the Mentoring Program. Two Boards serve in an advisory capacity to the WIE Initiative: the WIE Corporate Advisory Board and the WIE Faculty Advisory Board. Both Boards evaluate the effectiveness of the WIE Initiative, offer suggestions for strategies to increase the numbers of undergraduate as well as graduate students, and submit a summary report of their evaluations to the Dean of Engineering.

The *Corporate Advisory Board* is composed of eighteen national professionals representing the engineering profession, government and industry. It meets annually and provides counsel on programs, fundraising, and evaluation. An Executive Committee, composed of four local Board members, provides on-going assistance during the year. The *Faculty Advisory Board* was established to advise on mechanisms for encouraging female students to pursue graduate education. The Committee is also charged with evaluating the activities of the WIE Initiative, and providing input on ways to improve the current programs. The Board is currently composed of eight female faculty members, each representing one of the departments in the College of Engineering.

In addition to the overall evaluation by the Boards, an evaluation is conducted of each of the programmatic components, as listed on page 4. Student and professional feedback is gained through evaluation questionnaires, annual surveys, and individual interviews. Feedback from these evaluations is used to modify and improve the programs components. Finally, staff suggestions are gathered at weekly meetings and integrated throughout the course of the year.

The results of this year's evaluations have indicated a high level of success in accomplishing the Initiative's goals and objectives; recognition as a national model program for women in engineering; and surpassing national trends in enrollment and degrees granted to women in engineering.

Conclusion

With the support of the administration, faculty and corporations, the WIE Initiative has had a significant impact on increasing the percentages of women pursuing and obtaining degrees in engineering at the University of Washington. Perhaps as significant, the success of the WIE Initiative can be attributed to student involvement and student ownership in the many programs. It has been through their dedication and efforts that participation rates in WIE have increased from 10

percent to 65 percent in four years and that a climate conducive to both males and females in engineering is surfacing.

The WIE Initiative will continue to expand and modify its programs to meet the changing needs of students. WIE's goal is quality rather than quantity of programs. One of the new initiatives includes designing and developing a bridge program with the community colleges in Washington State, a collaborative effort of five colleges and the University of Washington, to ease the transition from a two-year institution to a four-year research institution for female science and engineering students. The steering committee will continue to be the catalyst for identifying new initiatives and for modifications to existing programs.

Formulated by the steering committee and the WIE Staff, the philosophy of the WIE Initiative is: *An academic and social climate in engineering, equally conducive and encouraging to male and female students, will foster increased interests and sustained desires to pursue engineering careers.* Recognizing that this balance does not yet exist, the WIE Initiative will deliver academic and retention programs until the enrollment and degrees granted to female students in engineering have reached parity with enrollment and degrees granted to male students. At the time of sustained parity, the WIE Initiative will be dissolved.

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OUT OF THE STREAM AND INTO THE RIVER:
Exploratory Courses in Trades and Technology for Women

Marcia Braundy

Le système de colonnes de classes, une philosophie largement reconnue dans les cercles d'enseignement, est fondé sur la stéréotypie sexuelle dans les professions. Des mesures spéciales doivent être prises pour assurer que les femmes à qui l'on a refusé la chance d'acquérir de l'expérience avec des outils et du matériel mécaniques ont désormais suffisamment de formation initiale pour développer les techniques nécessaires pour se qualifier dans les métiers, la technologie, l'exploitation et les emplois de col bleu.

Des expériences pratiques dans des matières diverses, avec des outils, dans un environnement agréable, qui permettent d'acquérir une certaine compétence dans l'utilisation des outils et la compréhension des théories techniques, sont à la base d'un système particulier qui a connu le succès au Canada. Combiné aux programmes d'aptitudes professionnelles, de rattrapage scolaire, d'affirmation de soi, sur la façon de surmonter les obstacles sociétaux, de dynamique de la vie, de planification de carrière et d'aptitudes de recherche d'un emploi, ainsi qu'à une solide expérience professionnelle, ces programmes permettent aux femmes de faire des choix de carrière informés. Les femmes qui pénètrent dans ces domaines techniques découvrent qu'elles sont bien préparées pour tenter d'exceller dans les domaines qu'elles ont choisis.

Différents cours préparatoires ont été mis sur pied dans le pays, variant dans leur durée, leur expertise technique et la qualité et l'engagement du soutien institutionnel. Ce document explore la raison d'être, les méthodes et les questions relatives à une programmation efficace qui permet de sortir les femmes des courants traditionnels fondés sur le sexe et de les inciter à s'engager en formation exploratoire et technique/professionnelle et à choisir des professions et des emplois qui leur permettront d'acquérir l'indépendance financière, la satisfaction professionnelle et les aptitudes techniques nécessaires pour construire notre avenir à toutes et à tous.

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627

OUT OF THE STREAM AND INTO THE RIVER:
Exploratory Courses in Trades and Technology for Women

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Streaming, an accepted philosophy in educational circles, has been based upon and resulted in the gender stereotyping of occupations. Demographics demand we use all potential workers in the broad range of occupations. Special measures must be undertaken to ensure that women who have been denied experience with mechanical tools and materials are given sufficient orientation training to enable them to develop the techniques necessary to become successful workers and managers in trades, technology, operations, and blue collar work.

Hands-on exploration of several tool skill disciplines, in a woman-friendly environment, to gain proficiency at using tools and understanding technical theory, forms the basis of a special measure that has achieved success in Canada. When coupled with Occupational Fitness, Academic Upgrading, Assertiveness Training, Overcoming Societal Barriers, Life Skills, Career Planning and Job Search Skills, and a solid Work Experience component, these programs provide the basis for women to make informed career choices. Those who enter technical fields find they are well prepared to pursue excellence in their chosen fields.

Different preparatory courses have emerged across the country, varying in length, depth of technical expertise, quality and commitment of institutional support. This paper explores the rationale, methods and issues for effective programming to move women out of traditional streams based on gender, into exploratory and technical/vocational training, and on into occupations and jobs that will provide economic sustenance, worklife satisfaction and the needed technical skills for our future.

DEMOGRAPHICS

Let's start with a short demographic picture: From 1970 to 1985, there were 300,000 new entrants to the labour market every year. [1] The baby boomers were entering the world of work in force. Along with this trend, women were entering the labour market in greater numbers than in the past, and were staying, taking only short leaves - less than a year[2] - for childbearing and rearing. Canadian industry had many workers from which to choose.

In 1990, there were approximately 180,000 new entrants to the labour market, just a little over half what existed in the 70s and '80s.[3] That number will decline every year until 2010. The 1990's entrants have a much more diverse make-up. Women, visible minorities, Aboriginal people and people with disabilities now make up a vast majority of the new entrants.

Many of these new entrants are adult learners. They are women who are re-entering the labour force after long absences or who find themselves unable to support a family on the traditional low wages of unskilled, often part-time, work to which women have been relegated in the past. They are Aboriginal people who are developing more skills which will enhance their

abilities to manage their own affairs. They are immigrants, both women and men, who for social or political reasons find themselves in a new and foreign country with unrecognized credentials.

NEED TO TRAIN & TO RETRAIN BEFORE WE LOSE OUR OLDER WORKERS

Regardless of the reasons, the reality is that integrating these new workers has become more than a social justice issue. It is an economic necessity. This integration process will be one of the major challenges facing adult educators in the 1990s.

We must not only educate, but we must also re-educate: both our students and ourselves. And we must train for skills needed right across the country, as we face the aging and "middle aging" of our skilled workforce.[4] "New manufacturing industries that rely on advanced production technologies and knowledge -intensive activities will have different labour requirements than the older industries they will be replacing.....There will be less need for semi-skilled or unskilled workers in manufacturing. There will be more demand for skilled technical and tradespeople."[5] While other countries are competing for a portion of the world markets with Canada, Canadian employers will be competing with each other for the shrinking numbers of workers, and particularly trained and skilled workers.

It is essential that we do not waste this opportunity to develop and maintain our competitive edge and cooperative potential with other leading industrialized countries. We must train and utilize the capabilities of all Canadians as well as those who have immigrated. "Firms wishing to ensure a steady supply of labour in future may be advised to seek our these "non-traditional" sources of labour through the provision of training and working conditions that are attractive to these kinds of workers."[6]

SPECIAL MEASURES MUST BE UNDERTAKEN

Special measures must be undertaken to provide women with the introduction and basic skill training necessary to ensure they have the opportunity to make career choices from the full range of occupations. They must address the other barriers that women experience - the multiple roles women play as workers and caregivers; the realities of poverty and childcare responsibilities that circumscribe women's lives; gender stereotyping and women's often limited experience with trades, technical and operational (TTO) work.[7]

The overall training needs of the designated groups must be met, along with the specific technical skills. To be successful, sponsors of programming must recognize the differing needs. They must develop, in consultation with WITT or other designated group representatives, adequate preparatory training, support and follow-up for women, as well as for members of other designated groups, either exploring or entering trades and technical training.

FROM HOMEMAKER TO TECHNICAL WORKER IS NOT A SIMPLE MOVE

It seems simple to say, "well then, women re-entering the workforce are an important source

of untapped or underdeveloped human resources to fill our requirements for skilled workers". At the same time we could reduce the social costs created by the fact that a large percentage of those women are working in the lowest paying clerical and service sector jobs[8], often jobs that are being eliminated through technological change and office automation. Many women are coming from situations of having been on social assistance for long periods, or perhaps have found themselves as sole-support parents after years of being a homemaker. It makes sense to look to this group as part of the solution to labour market issues.

But it is not that simple, because often, women have not had the preparatory training that would enable them to be successful workers in technical or blue collar fields. Streaming at earlier stages has tracked them away from the basic knowledge in maths and science and tool skills training that would have prepared them to be ready for this opportunity. Early socialization has trained them to think about the products of their productive lives in very different ways.[9] In order for many women to consider, then train and become qualified in technical and operational fields, they need to understand what it is, and how the skills that they have developed in their lives can be transferred into this new sphere.[10]

Not all women need this pre-training, some go quite effectively into technical training and onto the job without it. For those who will benefit, it is essential that all of the necessary elements are provided in these exploratory and pre-trades and technology courses.

Women's socialization process in Canada has ensured that they, for the most part, have not received basic orientation to tools and technical skills or developed the personal skills to operate effectively in male-dominated workplaces.[11] It is time for us to recognize and acknowledge the differing needs of women who want to become successfully integrated into all aspects of the trades and technical training, and ultimately into the technical or blue collar workforce. These needs will not be met solely by trying to change the women to fit the regular technical courses an institution already offers. They will be effectively met only when training hosts recognize that women need not only additional, but sometimes very different preparation to become successful trades and technical workers for Canada. Profiles of men who make successful tradespeople differs significantly from profiles of women who make successful trades or technical workers.[12]

Often men benefit as well from some modification of teaching and learning styles. Carol Brooks and Susan Booth discovered that some 93% of females in WITT exploratory courses in Ontario, and some 60% of men are "relational" learners.[13] Relationally-centred learners do best when they are able to: interact with other, relate personally to the instructor and other learners; start from their personal point of view and experience, build on and generalize from that; express their feelings; feel relaxed; receive personal positive feedback; have variety in the learning situation; use their creative abilities as a learning tool.[14] The learning environment must allow for a lot of personal attention from the instructors. The instructors must discover and respect learners' prior knowledge and experience. This can only happen in small groups and fairly informal settings. Most bridging programs try to provide these conditions.[15] Both women and

men can benefit from these more flexible teaching strategies.

SELF ESTEEM IS A BOTTOM LINE ISSUE

A 1989 national study showed that one of the most significant benefits of Women In Trades and Technology exploratory courses was the high increase in self-esteem experienced. [16]

In that survey, contracted by Employment and Immigration Canada, of the graduates of these pre-trades and technology exploratory programs, 75% of the respondents had gone on to further training in a trade or technical area. 63% of all of those surveyed were employed and 46% of those were working in a trade or technical area at the time of the survey. Many of those interviewed made it very clear that it was not just the assertiveness training, problem solving or self-esteem building workshops incorporated in the training that made the difference in their self-confidence. It was the hands-on exploratory in the shops, the tool identification and learning how to use the tools safely and effectively. They attributed their labour force success to the competency base that came from tool skill development as well as the development of personal skills and resources to manage the new work environments.

WITT COURSES PROVIDE BROAD RANGE OF BASIC AND NEEDED SKILLS

Over the years, a number of different exploratory courses have been developed at various colleges across the country. They vary in length, and they especially vary in the depth at which technical theory and practical tools skills are incorporated into the curriculum. Sometimes it has been due to a lack of understanding of the value of the hands-on portion. In other cases, only the hands-on portion is provided, leaving out the life skills, personal and occupational fitness development. It is clear from the many outlines and evaluations that all aspects are essential. Some people call these "bridging programs".

"Bridging Programs are affirmative action programs. They compensate for inadequacies in people's earlier education or learning. They assume that people were unable to acquire necessary information or skills earlier because of socio-economic circumstances or membership in a particular group. Bridging programs are meant to provide some compensation for systemic barriers in formal and informal education. They aim to alleviate systemic disadvantages and to assist in gaining access to, or in successfully completing training and job searching."[17]

I would like to distinguish here between Bridging Programs per se, and WITT type exploratory courses. Bridging Programs, generally, are those that assist people, often women, who are entering or re-entering the labour force, to develop life skills, career planning and job search skills. Often, academic upgrading is built in, to allow for the development of entry level requirements for a chosen occupational field. Although the idea of pursuing a career in a trade, technical or blue collar job may be introduced, it is not explored in depth. There is usually some emphasis placed on Computer Literacy, but more of the focus is on Self-Assessment, Communication skills, Job Market Research, Decision Making and Goal Setting, Assertiveness,

Managing the Requirements of Home and Work, and Problem Solving. There is a Workplace component to put some of these newly learned skills into action. The idea is to create a "Bridge" from home, or minimal labour force attachment, to either training or employment of some kind.

WITT exploratory courses contain most of the units described for Bridging Programs. But they focus more particulary on Examining Labour Market Trends and Employment Opportunities in Trades and Technology, actually Developing Occupational Fitness, Safe Work Practices, and on theory and practical expertise in a variety of trades and technical areas. These would include many of the components that are useful across the technical areas - for example: Processing Technical Information, Drafting and Blueprint reading, and Using Basic Measuring, Layout, Hand and Power Tools in Carpentry, Electrical, Metal, Mechanics, Robotics, Forestry shops, truck driving, building maintenance, etc. - and areas in the technologies where women have also been previously under-represented i.e. electronics, computers, construction and forest technologies, aerospace, and others. A course might feature 4 or 5 of these technical subject areas in some detail, depending on the local/regional industrial requirements. At the same time, the students would be learning about the responsibilities and rights of workers and employers on the job, Industrial Health and Safety, Overcoming Societal Barriers that may be encountered, Human Rights and Employment Equity Legislation and other realities of the industrial workplace.[18]

In WITT courses, there are often tours of construction sites and industrial workplaces, and films and discussions with women who have effectively entered these occupations. These are role models who can describe the joys and sense of tangible accomplishments as well as the challenges, and how best to prepare for them. The students have at least one and sometimes more 3-4 week work experiences on-the-job, to get a strong understanding of the requirements of that occupational area. These are not Powder Puff courses, and must be given access to the Institutional resources and facilities to become the rigorous training ground necessary to prepare women to work successfully in trades, technology and operations (TTO) work.[19]

Successful courses are 5-6 months in length, full-time, and women are prepared to make informed career decisions about which, if any, trade or technical training area to pursue, or what other area might be of greater interest. Because she has had the opportunity to climb the scaffolding, work with the men, work in the grease, the tools, the wiring, in the forest, with the transistors, the robots, etc., the choice she makes to enter further technical training will be a committed one. If she decides that the skills or the environment are beyond her present capabilities, and decides to go to work as a bus or truck driver, a correctional officer, a groundskeeper, a teacher's aide, a clerk, is that any less of a success? But the reality is that 63% of the women who went through exploratory courses (1983-1987) were employed a the time of the survey (1988) and another 12.8% were still enroled in training.[20]

ROLE MODELS IN THE TECHNICAL CLASSROOMS

The importance of role models of successful women workers in technical areas cannot be

stressed enough. As well as having working women address the students during a classroom panel, or during occupational research, it is also important for the students to work with women as instructors who are competent with tools.

If an instructor/coordinator were hired on a full-time, permanent basis, there would be ongoing follow up and support for graduates. Her job would include participant selection, life skills, &/or tool orientation, assisting vocational/technical instructors in the shops, organizing work placements and follow-up - clearly a full time job, and a very important role model to the female, and male student population at a vocational institution. She should be someone who has had real on-the-job experience in industry, so that she can bring to the students a good understanding of what the workplace is like, and what some of her coping strategies have been in overcoming barriers encountered.

BEYOND THE "NON-TRADITIONAL" TO TTO JOBS

Sometimes these courses have been referred to or named as introductions to "non-traditional occupations for women". The WITT National Network has been actively advocating for a change in that terminology. Since men have been doing these jobs for years, referring to them as "non-traditional" only when women do them sets those women apart as if they don't really belong. Many young women do not want to be "non-traditional", they want to be just like everyone else, but they would like to earn more money! We talk about the jobs, not the characteristics of the women doing them. Trades, technology, operations and blue collar work TTO/BCW.

INVOLVING THE "PRIVATE SECTOR" ON ADVISORY COMMITTEES

It is important to bring all the players with information, knowledge and resources to the table to discuss curriculum content and program implementation. When the National Task Force on Apprenticeship met in 1989/90 to discuss labour market issues, they recommended that WITT exploratory courses be set up in every college in the country, with Advisory Committees of unions, employers, WITT advocates and educators, to ensure that everyone who had a part to play in the successful training and integration of women in these courses and on to the job was able to have input into course development.[21] This can ensure the support and networks of industry are already engaged, and invested in the potential success of the program when the time comes for women to enter the work experience portion of the course. WITT advocates and WITT instructors on these committees can bring perspective on women's learning needs to the table.

WOMEN TRAINING WITH WOMEN

WITT National Network has developed, in conjunction with our labour market partners, a model set of **National Standards and Program Development Guidelines**[22] which best fulfill the identified and analyzed needs of both women and industry in preparing women to meet the challenges of integration into the TTO/BCW workforce. This standard includes the need for

women-only courses at the exploratory level.

It is still difficult for men and women to learn these new skills together. "It is important that the students test out their learning in situations where they will be judged against themselves, rather than the man standing next to them who may be at a very different place in his development. Women at similar stages of learning, competing and co-operating with each other can provide a healthy and productive atmosphere to grow in. Once a woman has achieved some general mastery, she is then ready to enter training and employment on a more equal footing."

As we move into training more women and other designated groups in technical occupations, there must be a recognition of the differing learning styles and training needs of the students. Clearly, there is education that can take place on both sides, learning that will sustain both the male students and instructors, and the women. However, it is vitally important that the women receive the pre-training they need to assist them to operate effectively, on more equal footing as they go on into the regular technical classrooms.

For this whole training program, the goals are:

1) To introduce women students to the range of possible occupations in trades and technology fields.
2) To develop strategies for dealing with the multiple roles of working women.
3) To provide academic upgrading in math, science and communication skills to enable participants to pursue further training and employment options.
4) To provide in-depth exploration and skill development in a wide range of Trades and Technologies.
5) To provide labour market information, career planning, assertiveness training, and job search skills to assist students to make informed career choices.
6) To provide hands on use of hand tools and power tools in a training shop setting.
7) To provide hands-on work experience in industry assuring realistic consideration of potential work environments and the students' abilities to adapt to those situations.
8) To provide basic background in group format necessary for students to enter regular trades and technical programs.
9) To provide sustained and effective support throughout the entire transition from home, unemployment, or underemployment to a training program or appropriate employment in a job with a salary sufficient for the economic responsibilities of the participant.

Achieving these goals will meet the following objectives:

1) The employment potential of participants will be increased especially in trades and technology areas.
2) Participants will identify and explore a broad range of employment and training opportunities in trades and technology fields.
3) Women who complete this course will have a realistic understanding of the physical, emotional and academic requirements of training and employment in trades and technology work, and will have developed a series of skills to assist them in becoming competent workers in these areas.[23]

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One classification of learning styles gaining credence in women's bridging programs was developed by Dr. Sandra Segal and popularized in [Canada] by Susan Booth and Carol Brooks. They suggest that three learning styles interact in everybody's learning process, but that one style is consistently prominent in each person. The three learning styles are:

> **Mentally-centred:** idea development, overview, focus, clarity, objectivity, precision, solitary learning, structure, attention, observation, rules, visual, conceptualizing, analyzing;
> **Relationally-centred:** personal relevance, verbalizing relating, connecting, creative imagination, peer learning, sensitivity, resourcefulness, assessing, planning, organizing,auditory, modelling, personal expression, creative expression, variety;
> **Physically-centred:** hand-on, practice, practical application, practical problem solving, repetition, drill, completion, kinaesthetic, demonstration, pacing, time management, experimenting, tinkering, tactile.

The learning process has three parts: **thinking, planning/assessing, and doing**.
Brooks and Booth estimate that 80% to 85% of the North American population are relationally centred learners while 10% to 15% are physically centred. Unfortunately, our education system is primarily organized to be appropriate for the 3% to 10% who are mentally centred.
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17. Shelly Gordon. **Operation Access:** p.80

18. Marcia Braundy. **Orientation to Trades and Technology**. All of the activities described in this and the previous paragraphs are outlined in this book in terms of performance objectives, with learning activities and teaching strategies provided along with some hand-outs and lists of further resources and teaching aids.

19. The information in this whole section is drawn from 20 or more course outlines and evaluations of courses in Canada. Those in my collection date from Saskatchewan, 1979 and are sprinkled across the country during the 1980's, including the Durham Study and the National Study of WITT Graduates. The same information is reflected in **The Nuts and Bolts of NTO** and outlines and evaluations from Trident Technical College and others in the US.

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WOMEN IN SCIENCE IN EASTERN INDONESIA UNIVERSITIES

Hilda Ching

Women in Science and Technology (WIST) est un projet d'intervention du Eastern Indonesia Universities Development Project de la Simon Fraser University, en collaboration financière avec le Programme canadien de développement international et le gouvernement de l'Indonésie. Au cours des cinq premières années, 3 conseillères canadiennes successives et une conseillère indonésienne ont travaillé avec des cadres en vue d'établir des objectifs clairs visant à renforcer le rôle des travailleuses scientifiques, de sensibiliser les gens aux questions relatives aux sexes, d'intégrer les préoccupations des femmes à toutes les composantes et à tous les informations du projet et d'élaborer un plan de travail et un budget globaux. Les programmes WIST sont fondés sur les principes de Tri Dharma pour l'enseignement, la recherche et l'approche communautaire. Les résultats matériels incluent un engagement solide à l'égard des programmes WIST de la part du personnel de gestion, une reconnaissance formelle des participantes et participants aux programmes WIST dans les campus, et une participation accrue des travailleuses scientifiques aux congrès. La tâche a demandé de nombreux efforts parce qu'elle était répartie entre 4 campus et trois universités, et que les problèmes de communication étaient nombreux. Il est essentiel que toutes les participantes et tous les participants comprennent désormais l'échange et la transformation des cultures occidentales et indonésiennes dans les domaines de l'enseignement des sciences, du féminisme, de l'enseignement et de la recherche. Les travailleuses scientifiques indonésiennes sont semblables aux autres professionnelles en ce qu'elles obtiennent des grades supérieurs en même temps qu'elles élèvent leurs enfants et assument leurs responsabilités académiques, et en même temps qu'elles participent à la planification des politiques et à la prise de décisions. Le projet a été renouvelé pour 5 années supplémentaires; il comporte désormais des plans visant à accroître la contribution des femmes dans l'enseignement des sciences, la gestion et le développement de réseaux internationaux durables entre les femmes et les sciences.

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637

WOMEN IN SCIENCE IN EASTERN INDONESIA UNIVERSITIES

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ABSTRACT

Women in Science and Technology (WIST) is an intervention strategy of the Eastern Indonesia Universities Development Project, Simon Fraser University, with co-funding from the Canadian International Development Agency and the Government of Indonesia. In the first 5 years, 3 successive Canadian women advisors and 1 Indonesian consultant have worked with managers: to develop clear objectives to enhance the role of women scientists, to increase awareness of gender issues, to integrate women's concerns into all components and delivery vehicles of the project, and to have an overall workplan and budget. WIST programs follow the principles of Tri Dharma for teaching, research, and community outreach. The tangible results include strong commitment for WIST from the management, formal recognition of WIST groups on campus, and increased participation in conferences with women scientists. The work has been challenging because it is spread over 4 campuses of 3 universities with many communication problems. The need for all participants is to understand the exchange and transformation of western and Indonesian cultures as to science education, feminism, teaching and research. Indonesian women scientists are similar to other career women in acquiring advanced degrees concomitant with child bearing and academic responsibilities, and in participating in policy planning and decision making. The project has been renewed for another 5 years with plans for increased contributions from women in teaching science, in management, and in developing sustainable international linkages with women in science.

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EQUITY CURRICULUM FOR ENGINEERING STUDENTS: A PILOT PROJECT

Wendy Cukier

Ce document aborde la mise sur pied d'un module pour la première année des cours d'éthique et de professionnalisme de six programmes agréés de génie de l'Institut polytechnique Ryerson. Le module vise à rehausser la compréhension du problème de la discrimination sous toutes ses formes - discrimination fondée sur la race, le sexe, les aptitudes, l'âge, etc. - ainsi que l'importance de l'équité et des stratégies en vue d'un changement. Le module comprend l'autoévaluation, une discussion sur la nature des problèmes et une exploration des stratégies pour le changement. Ce document traite de la conception, de la prestation et de l'évaluation pédagogiques du module, ainsi que des implications d'un modèle de marketing social.

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EQUITY CURRICULUM FOR ENGINEERING STUDENTS: A PILOT PROJECT

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ABSTRACT

This paper will review the development of a module for first year Ethics and Professionalism courses in six accredited engineering programs at Ryerson Polytechnical Institute. The module was aimed at building understanding of the problem of discrimination in all its forms - racism, sexism, ableism, ageism, etc. - as well as the importance of equity and strategies for change. It included self-assessment, a discussion of the nature of the problems, and an exploration of strategies for change. This paper will discuss the instructional design, delivery and evaluation of the module as well as the implications of a social marketing model.

INTRODUCTION

The Committee on Women in Engineering of the Canadian Council of Professional Engineers issued More Than Just Numbers in April 1992. The report identified factors which impede the progress of women in engineering and established goals to increase their participation. The Committee also made 29 specific recommendations and established a timetable for implementation. One of its recommendations was the incorporation of gender-related and equity issues in engineering curriculum by 1994. (CCPE, 1992), a recommendation supported by the Canadian Council of Deans of Engineering and Applied Science. Ryerson Polytechnical Institute received accreditation for its engineering programs in 1992 and began to implement modules on equity in its first year Professionalism courses in a project supported by the Ontario Ministry of Colleges and Universities.

CURRICULUM DEVELOPMENT

The purpose of the module was to lead students to:
- examine their own assumptions and beliefs
- understand the forces preventing women from entering engineering
- understand the extent of racism in Canada and to recognize its manifestations
- understand the nature of discrimination
- understand their professional and legal obligations
- understand that these issues are relevant to engineers
- understand the importance of individual action

The principal constraint was time. Only two hours in the first year professionalism acourses were available. In some cases, the classes had 100 students making meaningful discussion. difficult. In addition, the availability of expertise on campus was limited. A business faculty member was asked to deliver the module.

Ryerson Polytechnical Institute's Engineering Faculty has one of the lowest rates of female enrollment in Canadian Universities. This is partly a function of its history prior to accreditation. It has, however, a relatively high rate of visible minority students.

Table 1: Ryerson Polytechnical Institute Student Profile

	Percentage of visible minorities, (1991/92)	Percentage of females (1992/93)
Chemical Engineering	47.4%	31.5%
Industrial Engineering	41.1%	11.6%
Electrical Engineering	34.7%	5.2%
Aerospace Engineering	32.9%	3.4%
Survey Engineering	31.8%	15.3%
Mechanical Engineering	23.1	4.3%
Civil Engineering	19.0	14.4%
Total	n/a	8.0%

When dealing with typical university subject matter, the authority of the instructor stems from mastery of the content. However, in a discussion of equity, where attitudinal change is a principal objective, the relationship between the instructor and the student is critical. A fundamental concept in marketing is the need for the audience to identify with the spokesperson. Otherwise the presentation may have exactly the opposite effect of what is intended. Campaigns with good messages can fail because of the inappropriateness of the spokesperson. (Richler, 1992) Advertisements, for example, with geeky looking kids in buttoned down collars and polyester pants advocating "Say no to drugs" probably contribute the popularity of illicit substance abuse. Rather than compliance they were more likely to generate the converse "If geeks don't do drugs, I will."

The importance of the messenger cannot be overestimated. (Petty and Cacioppo, 1981) Having women speak to predominantly male audiences on the importance of equity in engineering is risky. Better to establish their authority by having them display their expertise on core engineering issues. In an environment where women are marginalized, their message on equity may also be marginalized. Although it may be construed as reinforcing male authority, at Ryerson where only 4% of Engineering faculty are female and where the student population is predominantly male, the most obvious role model would likely be a male engineer. At the University of British Columbia the compulsory equity components are incorporated into a course which is

taught by the Dean of Engineering and Applied Science. (Meisen, 1992). However, at many institutions the expertise and commitment to these issues is concentrated among female faculty members. At Ryerson, the task was assigned to a white female who was not an engineer. The potential risks were identified at the outset and the engineering instructors were asked to carefully position the material. In the case of the Electrical Engineering, the professor made it clear that the module was an important component of the course and stayed for the class. In the case of Mechanical Engineering the professor did not attend the classes.

Many of the materials which were very informative and effective for an audience responsive to the message, were not ideal for the audience. For example, the outstanding video, The Chilly Climate, produced by the University of Western Ontario did not seem appropriate to an audience which would be predominantly young, male and skeptical. Concordia University's Inequity in the Classroom materials was extremely useful but geared to teachers rather than students. An analysis of the situation revealed both challenges and risks. It was possible that the students would:

- reject the message because of the messenger
- reject the message because of the form of delivery
- reject the message because it confronts deeply held beliefs
- reject the message because it is not believed to be relevant
- reject the message because it was too "preachy"
- not understand the message because of the inadequate time

Because of time constraints, the size of the classes and the other factors, a highly interactive session was considered risky. Given the small number of female students, it was clear that a "sharing" approach could put them in an awkward position. At the same time, there was a risk that visible minorities students would object to a white person speaking on racism. A team teaching approach was suggested, but could not be accommodated within the constraints.. The following guidelines were adopted to address the risks:

- root the presentation where possible in fact rather than belief or values
- avoid preaching or coercion through guilt
- focus on building awareness of their own attitudes and knowledge
- avoid putting minority students especially women "on the spot"
- control discussion
- stress links between racism and sexism
- emphasize the importance of equity to the profession rather than its moral basis
- establish links with the students' experience and frame of reference

APPROACH

Session 1, began with a Self-Assessment Quiz which gave the students an opportunity to reflect upon questions related to gender as well as race and highlighted:

- the low proportion of women in engineering at Ryerson compared to other institutions
- the high percentage of female engineering students who report having been harassed
- Canada's history of racism and continued discrimination
- problems of collaboration/passivity/inaction
- the student's knowledge (or lack thereof) and attitudes to issues related to sexism and racism

During the discussion of the questionnaire, evidence which runs contrary to common assumptions was presented from More than Just Numbers and the report of the Ontario Federation of Students Whitewashed: Institutional Racism in Post-Secondary Institutions. The impediments to women who wish to enter the field starting with the early socialization of girls, through the school system, to bias in the university system and employment were identified. Surveys which indicated the extent of the problem were cited. Ryerson's record on attracting female engineering students was contrasted with the national average and that of universities such as Queen's to illustrate that it is possible to attract more women. Canada's record on racism was presented along with evidence that discrimination persists today. Cultural bias in educational materials was illustrated by the history of white European conquerors and the controversy over the celebration of the 500th anniversary of Columbus' arrival in America. The importance of gender in language and cultural stereotypes were presented. Links between sexism and racism were drawn.

The material was presented in a factual way, but an effort was made to reinforce individual responsibility. For example, most students acknowledged that racist and sexist jokes were not harmless. But when asked "How many of you have heard a joke that you thought was racist or sexist? How many of you have laughed? How many of you said that it wasn't funny?", it was clear that few had acted on their convictions. The results of Stanley Milgram's experiments on obedience (Deaux, 1984) were presented to illustrate the tremendous influence of authority on human behaviour. The session concluded with a re-emphasis that problems of racism and sexism persist and that all students have a responsibility for the university climate.

Session 2 focused on the difference between overt and systemic discrimination and the legal obligations of employers and employees in terms of the Human Rights Code. The Human Rights Guidelines regarding questions which are permissible and not permissible in job applications were discussed. Students identified examples of how the code is often violated in job applications. Initiatives flowing from More than Just Numbers targeted at the schools and universities were presented. The role of the media in shaping attitudes through reinforcing stereotypes was discussed with examples drawn for children's toy catalogues showing only boys driving cars and girls making tea. Examples of progress in the media, such as changes in

newscasting, men doing laundry in commercials, women buying cars, etc. were identified. The Canadian Advertising Foundation's Guidelines on Sex Role Stereotyping were distributed and reviewed. Again the links between sexism and racism were emphasized. The role of the consumer in shaping the media was emphasized. To illustrate changes in popular culture and ways in which media can exert positive influence, there was a discussion of the original Star Trek in comparison to Star Trek:The New Generation, a television show popular with over half the class. While the original Star Trek did address the issue of racism, sexism was an inherent and unquestioned component of the show. Although it is still no feminist utopia, Star Trek: the New Generation, confronts assumptions about race, sexism, and homophobia. A film clip from Star Trek: The New Generation of a matriarchal planet where men are dressed in revealing clothes and treated as intellectually challenged, decorative servants, was used to add comic relief and as a focus for a discussion on stereotypes and media influence. There was then a discussion of the countervailing forces - the backlash . Students were able to cite examples from films featuring homicidal women. The conclusion emphasized the importance of the issue to the profession and individual roles in effecting change.

EVALUATION

The principal function of the Self Assessment Quiz was to encourage the students to examine their own knowledge, assumptions and beliefs but it also provides a benchmark. While some students changed their responses during the discussion, the results on several questions are interesting. The class was split on a number of issues and some of the responses seem contradictory. For example, 51.4% felt there were few impediments to women who want to enter engineering and 50% felt that "no one tells women they cannot be engineers". Yet at the same time, 80% felt that you could interest more women in engineering and 63% felt that female engineering students do experience problems. While they divided on the statement "boys and girls are treated the same in public school", most (69%) felt that they were treated the same at university. They were also evenly divided on the statement "the universities are relatively free of gender and cultural bias". The vast majority of students (85%) did not believe that racist and sexist jokes are harmless. At the same time, the majority (48.6%) felt that "concerns over gender neutral language are silly". Only 36.5% disagreed and 17.4% did not respond. The majority believed that students could do something if their professors make sexist and racist remarks (77%). But at the same time, they indicated that they believed that most people will not speak out if they see something obviously unfair or harmful (61%). Most (71.6%) disagreed with the statement that equity is only an academic issue and not of concern to the profession. About two thirds of the students had knowledge of such issues as the ethnic mix in Canada, Canada's history of banning immigration

by ethnic groups, and the fact that aboriginals were unable to vote until 1959. Of the total respondents, 38% believed that refugees were a burden to the Canadian economy. Only 33% of electrical students (n= 74) answered that this was true compared to 50% of mechanical students (n=41). This may reflect the higher percentage of students from visible minorities in the electrical engineering session.

Table 2: Self Assessment Quiz - Key Questions (N = 115)	True	False	N/R
There are few impediments to women who wish to enter engineering	51.4%	43.0%	4%
No one tells women they cannot be engineers	50%	32%	18%
Boys are more likely than girls to prefer science, math biology and chemistry	59%	36%	4%
You cannot interest more women in engineering	13.5%	80%	6.5%
Most female engineering students do not experience problems.	33.8%	63.5%	2.7%
Boys and girls are treated the same in public school and high school	49.%	49%	2%
Male and female students are treated the same in universities	69%	31%	
While racism and sexism may exist,the universities are relatively free of such bias	46%	46%	8%
Most people will speak out if they see someone doing something obviously unfair or harmful	32%	61%	6.8%
Sexist and racist jokes are harmless. It's best just to go along with them.	8%	85%	6.8%
Student cannot do anything if their professor make sexist and racist comments	13.5%	77%	8%
The concerns over gender neutral language are silly. There is nothing wrong withusing "He" in the generic sense.	48.6%	36.5%	6%
Equity is only an academic issue. It's not really of importance to the profession	14.9%	71.6%	13.5%

The results of a brief Evaluation at the end of the first session suggested that the majority found the session interesting, relevant and understandable. They also indicated that there was inadequate time for discussion, a valid comment There were only couple of overtly negative evaluations.

Table 3: Session 1 Evaluation		Strongly Agree 5	4	3	2	Strongly Disagree 1
1. The quiz was interesting						
Electrical	(n = 64)	21.9%	32.8%	39%	1.5%	4.6%
Mechanical	(n = 41)	14.6%	46%	29%	2.4%	4.9%
2. The presentation was interesting						
Electrical	(n = 64)	31.3%	32.8%	28%	4.6%	3.1%
Mechanical	(n = 41)	19.5%	51.2%	22%	2.4%	4.9%
3. This material is relevant to my profession						
Electrical	(n = 65)	38.5%	33.8%	23%	3.1%	1.5%
Mechanical	(n = 41)	24%	43.9%	29.3%	2.4%	2.4%
4. There was enough time for discussion.						
Electrical	(n = 64)	9.4%	20.3%	23.4%	26.6%	20%
Mechanical	(n = 41)	19.5%	19.5%	19.5%	34.1%	7.3%
5. I understand the material						
Electrical	(n = 64)	41.9%	37%	17.1%	1.6%	1.6%
Mechanical	(n = 41)	51.2%	24%	19.5%	2.4%	2.4%
6. Compared to other material in this course, this was interesting.						
Electrical	(n = 64)	25%	32.8%	31%	7.8%	3.1%
Mechanical	(n = 41)	27%	41%	14.6%	7.3%	9.7%

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Approximately 65 electrical engineering students attended the Session 2 compared to 80 who attended the Session 1. There was no time for evaluation but the students participated actively and applauded at the end.

Session 2 for one mechanical engineering class was disrupted by a small group of students who repeatedly interrupted the instructor and called out inappropriate remarks. The session was not completed and no evaluation was conducted. There are a number of possible explanations for the behaviour. Almost half the class had not attended the previous session which set out the dimensions of the problems and established a context for the discussion. There was limited time for discussion and the students may simply have wanted an opportunity to express their opinions on material which they regarded as controversial. However, the principal reason appears to have been the absence of the regular instructor and a lack of authority conferred on the instructor teaching the equity module. This emerged in the first session for this particular class. When asked what they had been told to expect, one student yelled out "He told us that a gorgeous blonde was coming to teach us about human relations." While there is no reason to believe that the instructor made such a comment, the remark reflects the attitudes of some students, to the subject matter as well as the instructor.

The Acting Dean of Engineering intervened promptly by arranging to introduce subsequent classes, by ensuring that the instructors would be present, and by discussing the matter with the students involved. When second session was offered to another group of mechanical engineering students, the Acting Dean of Engineering introduced the equity instructor and emphasized the importance of the material to the profession. The presentation went smoothly and the evaluation suggests that the majority in attendance found the session interesting, understandable and relevant.. Nevertheless, only about half the class attended.

Table 4: Session 2 Evaluation (n= 14)

	Strongly Agree 5	4	3	2	Strongly Disagree 1
1.The Star Trek episode was interesting	50%	21%	21%	7%	-
2. The presentation was interesting	43%	21%	36%	-	-
3. This material is relevant to my profession	36%	36%	21%	7%	-
4. There was enough time for discussion.	-	38%	46%	15%	-
5. I understand the material	50%	43%	7%	-	-
6. Compared to other material in this course, this was interesting	36%	50%	14%	-	-

Of 100 final examination questions for the Electrical Engineering students, 8 were devoted to equity. They were fairly easy and a sampling of 20 papers showed that the average student scored 7 out of 8

CONCLUSIONS

While a number of institutions have introduced "Women in Engineering" courses the students tend to self-select in that those with an interest in the subject enrol. Even in a compulsory course, attendance is uneven and it is reasonable to assume that students who disagree with the material or are uninterested choose not to attend particularly if they have the impression that the material is not relevant. Consequently, many who would benefit most are not present. For this reason it is important to integrate the material into required courses and to position it as central to the curriculum and to the profession. The development of the equity module for first year engineering students at Ryerson was not rigorously studied, controlled or evaluated. However, the data that was collected suggests that:

1. The material should be incorporated into required courses.
2. Sufficient time must be devoted to exploring the issues in some detail. Two hours was not sufficient
3. The instructor must be positioned as an authority.
4. The material must be established as essential to the course and professional practice.
5. Administrators and Faculty members must reinforce the importance of the material.
6. The students should be evaluated on the material through assignments and examinations.
7. Even if the majority of students are receptive to the material, it is sufficiently controversial that there will be strong opposition among some students. A small number can disrupt the class and poison the atmosphere.
8. Linking the discussions of racism and sexism works well with an ethnically diverse audience.
9. The use of humour and reference points in popular culture help hold the students' interest
10. For large classes where discussion is not possible, self assessment is a useful tool.
11. A focus on enlightened self-interest and empirical evidence,rather than moral imperatives, seems to work.

Leadership is an indicator of the direction and priorities of an organization and is a catalyst for social intervention. (Mintzberg, 1989) The key to the success of initiatives will depend to a large part on the commitment of the leaders in the engineering field - men as well as women. In the academic setting, leadership comes from the administration, from faculty and from the students themselves. For equity to become part of the culture, there needs to be a commitment to an integrated approach to change. Social marketing is defined as a form of marketing which attempts to change the perceptions, attitudes and opinions that underlie an individual's lifestyle (Kotler and Zaltman,1971). Social marketing programs have been used to promote changes in behaviour regarding drug use, alcohol and driving. It requires careful analysis of objectives, targets and vehicles. Normally a social marketing model will develop a series of complementary initiatives to foster change. In the context of a social marketing model, the introduction of the equity module to the curriculum represents only one initiative and needs to be reinforced through a variety of means. To implement the recommendations of More than Just Numbers, Ryerson will need:

1. Comprehensive recruitment and retention strategies for female students.

2. Transitional and qualifying programs for mature students.
3. Awareness programs directed at faculty and administrators.
4. Reinforcement of the equity curricular material in all years in the program.
5. Review of instructional materials and strategies for gender and cultural bias.
6. Reinforcement of the equity message in all promotional materials and programs.
7. Allocation of sufficient resources to reinforce equity and counter discrimination and backlash.

While Ryerson has made significant efforts in the area of women in engineering, most notably through its successful Summer Camp, a comprehensive strategy is needed to effect change. The decision to appoint a special assistant to the Dean of Engineering to work specifically on the issue of women and engineering is the first step to a coordinated approach. Although there is a broader agenda for change, the Faculty of Engineering has taken a leadership role at Ryerson in making equity a compulsory component of its curriculum. It is hoped that other faculties at Ryerson will follow suit.

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RECRUITING FEMALES INTO PHYSICAL SCIENCE AND ENGINEERING PROGRAMS AT THE UNIVERSITY LEVEL: A LITERATURE SURVEY

Sally M. Cumming and Martha L. Hendriks

La question des faibles taux de participation des femmes dans les programmes de sciences physiques et de génie des universités canadiennes est un sujet très à la mode dans toutes sortes d'écrits. En outre, on a déployé de sérieux efforts en vue de développer des stratégies et des recommandations de recrutement visant à accroître le pourcentage des femmes dans les programmes de sciences et de génie des universités canadiennes.

Parmi les auteures et auteurs de ces écrits, notons les gouvernements fédéral et provinciaux, les organismes professionnels, les universités (dans le cadre de leurs recherches institutionnelles) et les chercheuses et chercheurs elles-mêmes et eux-mêmes des universités.

On étudie certaines initiatives de recrutement particulières de l'Université de Toronto. Science Outreach, par exemple, est un camp d'été scientifique pour les étudiantes et étudiants des classes de la cinquième à la dixième années, dirigé entièrement par les étudiantes et étudiants avec l'aide administrative de l'université. L'objectif du projet Science Outreach est d'atteindre un taux de participation de 50 % des femmes.

Dans ce document, nous tentons de réunir les renseignements qui existent sur les stratégies et initiatives de recrutement et de reconnaître les défis que nous aurons à relever dans l'avenir.

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649

RECRUITING FEMALES INTO PHYSICAL SCIENCE AND ENGINEERING PROGRAMS AT THE UNIVERSITY LEVEL: A LITERATURE SURVEY

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Abstract:

The low participation rates of females in physical science and engineering programs at universities in Canada has been the subject of a great deal of literature. In addition, there has been considerable effort placed on recruitment strategies aimed at increasing the proportion of female participants in these programs. This paper is a review of the current literature on recruitment strategies and recommendations aimed at increasing the proportion of female students in physical science and engineering programmes at Canadian universities.

Authors of such literature include the federal and provincial governments, professional organisations, individual universities (as part of their institutional research) and researchers themselves within universities.

Some particular recruitment initiatives at the University of Toronto are examined. Science Outreach is a summer science camp for students from grades five through ten, run entirely by students with administrative support from the University. Science Outreach's goal is a 50% participation rate by females.

This review will attempt to consolidate the information available on recruitment strategies and initiatives, and identify the challenges of the future.

Introduction

Literature about the low female participation in the sciences is not new - it dates back at least to 1355, with Giovanni Boccaccio. Much

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

of the earliest work, like Boccaccio's, takes the form of lists of women who worked in science. However, the analysis of women's proper place in science also has a long history, for example, Gille Ménage argued in 1690 for the admission of women into the Académie française. The first conference on women and science took place in 1894 in Paris.

The more recent literature represents a renewed interest that began in the late sixties and much of it examines why, six centuries after Boccaccio, there are still so few women in physical sciences and engineering. Some of the factors indicated by the literature include: the lack of role models; socialization; climate/culture; and a male oriented curriculum. Many of these factors exist today in the classrooms and homes of young girls. The real lesson of Barbie (the one who finds math so tough) is that Mattel knows there is a market for her.

Scheibinger looks at three points of view commonly covered in literature: 1) that women cannot do science as well as men, for physical, psychological and intellectual reasons; 2) the absence of women from science is an access-to-education-and-employments issue; 3) that women must not only participate in science but change it, or as Ursula Franklin puts it: will women change technology or will technology change women?

Several Canadian studies by governmental agencies have addressed the issue of gender imbalance, (Council of Ontario Universities, Industry, Trade and Technology, Canada), with calls for action to university adminstrators, professional associations, and industry. Taken as a whole, the studies represent a thorough analysis of the

problem, and they describe the many factors that may be contributing.

However, change has been slower in the physical sciences and engineering, than in other fields. In September, 1992, 19% of the students in Engineering at the University of Toronto were female, representing an increase of 6.7% since 1983.

Engineering and the physical sciences offer careers that require a rigorous training in mathematics. Such preparation must begin by Grade 10 or 11, at which point, in Ontario, mathematics becomes optional in the secondary schools. For that reason, a commitment to the fields must be undertaken at an early stage in life, usually in the early to mid-twenties. In fact, the literature seems to indicate that attitudes to mathematics along gender lines are often formed in the pre-adolescent age. Therefore, to increase the trained female labour force requires a long-term strategy primarily aimed at grades 5 to 11.

Recruitment strategies:
While there is an abundance of literature on why there is a low participation rate of females in engineering and physical science programs at universities, there is a distinct lack of literature on *how* to change it - on programs in place. Are certain recruitment strategies more efficient and successful than others? Most of the literature on Canadian recruitment strategies is in the survey format, listing initiatives across the country.

A 1988 survey from York University (W.I.S.H.) lists fourteen initiatives taking place at ten Canadian universities, including: make-

up courses in math and sciences for those with no secondary school background in science; apprenticeship programs for young, female high school students; special one day events for prospective students; brochures. Also included are a brief description of some American recruitment programs.

More Than Just Numbers also has a list of initiatives as one of the appendices of the report; this publication by the Canadian Committee on Women in Engineering is the most recent and comprehensive study about the experience of women in engineering in Canada. It includes a discussion of many of the issues, for example, sociological factors, and relevant aspects of the educational and industrial experience. Some general recommendations and a list of different organizations that can be of help are included.

Another survey of recruitment initiatives is the unpublished collection of responses to a 1990 request for information by the Canadian Council of Professional Engineers. Several innovative strategies are in place. The University of Alberta, for example, offers a student summer research project where grade 11 high school students work with faculty as part of a research team for six weeks. This format does not reach large numbers of female students; however there is a significant amount of individual attention. The University of New Brunswick has established the Northern Telecom- NSERC Chair in Women in Engineering, a position that involves research, teaching in engineering and special initiatives for the recruitment of women. A telephone campaign at Queen's University contacts every admitted female and some male engineering students, to answer any questions the prospective students may have.

These surveys indicate that career days or open houses, brochures or videos, and the use of female role models are among the most common recruitment initiatives undertaken by universities. The career day or open house often does not usually target women specifically, except in the sense that it addresses the issue of a lack of information, sometimes cited as a contributing factor to the low female participation rate. In contrast to the research summer program offered by the University of Alberta, both the career day format and the brochure/video format have the potential to reach large numbers of prospective female students, but only with a very small amount of individual contact time. Another wide-spread initiative is the science camp.

Science Outreach

Science Outreach is a non profit, student-run organization founded in 1989 at the University of Toronto. Originally established at Queen's University, Kingston, in 1988, summer science camp programs are now available in at least sixteen universities across Canada.

The primary objectives of the program are to encourage young children to take an active interest in science, foster an understanding of the role of science and technology and to provide role models for boys and girls in science and engineering. Effort is taken to ensure that children of all backgrounds and abilities are able to participate.

The program at Science Outreach at the University of Toronto has two main components. During May and June, workshops are conducted in the elementary and secondary school system in southern Ontario. The two hour shows consist of a hands-on engineering design project and demonstration, and an opportunity

for questions, particularly as they relate to the experience of the staff. During July and August, weekly camps are hosted at the main campus of the University of Toronto. Admission to the camp is based on a short essay. Over the five day period, students are given a variety of activities, demonstrations, discussions and practical lab tours designed to be interacative.

The success of the Science Outreach program is due to the teaching methods and environment created by the instructors. A very selective and competitive hiring process provides the program with outstanding instructors who are primarily undergraduate degree students. Senior high school students are hired as junior counsellors and assistants.

Presentations are dramatic and fun, imagination is fostered through hands-on activities and discussions link science in the broader sense to other disciplines and applications in everyday life. Some of the presentations include: bungee cords to be made out of string and elastic, in order to learn about the properties of material strength and flexibility; baseballs, boomerangs, and frisbees are used to demonstrate Bernoulli's Principle and the Magnus Effect; "bubblology" examines the principles of geometry and attraction of molecules; and the egg drop, where students build a re-entry vehicle out of household items, like straws and cotton balls, that will protect the egg (their astronaut) when it is dropped from the second floor of the building.

In the first year of operation in 1990, 87 workshops were presented to 2200 school children. Over 140 children attended the on-campus weekly camps. Operations expanded in 1991, and in 1992, 425 workshops were conducted for 12,750 students and 629 students

attended the weekly camps. Female attendance, on average, was 40%. The operation budget grew from $25,000 in 1990, to over $100,000 in 1992. The project is funded by government, the University, the profession, industry and through modest registration fees.

A unique feature introduced in 1992 was a joint project with the North Shore Tribal Council, which represents seven bands. A one week camp was organized in northern Ontario for First Nations children. Science Outreach staff, in consultation with the Elders, developed and presented a curriculum which was sensitive to Aboriginal approaches to science and nature. The Tribal Council organized all other details including the necessary approval from the Native community, rental of a spiritual centre, selection of campers, and cultural performances such as the opening and closing ceremonies. **Ndakenjgwin Gbeshwin** was an outstanding success combining scientific and native culture. Other mutually co-operative projects between Science Outreach and the native community are planned.

American recruitment programs

Women and Minoirties in Science: Strategies for Increasing Participation is a series of papers, sponsored by the American Association for the Advancement of Science. Kreinberg describes the EQUALS program at the Lawrence Hall of Science, a science education centre at the University of California at Berkeley. The goals of the program are to help educators examine their expectations of girls and boys in math and science classes, and to assist them in developing and adapting materials and strategies to increase student confidence and competence. One unique feature of the program is the data collection scheme. Participants are asked to do a research

project in their school before attending the program. In this way, the EQUALS coordinators have gained access to information about a large number of students. Indeed, by focusing on educators, rather than individual students, this program potentially has a very wide audience.

Conclusions

The existing surveys of Canadian recruitment programs are useful for their breadth of ideas. There is a lack of information on program outcomes and about what particular aspects of the program lead to that success. Perhaps that which sparks interest and curiosity in a young mind is too elusive to be documented. However, some systematic collection of data is the next logical step. A current proposal before Industry, Science and Technology Canada to establish and national organization of science and engineering camps is a good first step towards an exchange of information between universities.

Because university recruitment programs tend to target female students from grades five to ten, there is a three to eight year lag before those students enrol in their first year of university. Because a career in the physical sciences or engineering almost always must be chosen in early high school, there is a narrow window of opportunity. Resources - both money and time - are scarce and only a limited number of options for recruitment of women may be pursued. It is, therefore, even more important to be as efficient as possible and discover as quickly as possible what works and what doesn't.

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ANIMAL RIGHTS AND BIOLOGY PRACTICE

Anne Innis Dagg

Ce document examine les diverses façons de diminuer l'usage d'animaux de laboratoires dans l'enseignement universitaire et dans la recherche sur les comportements animaux. Il met l'accent sur cinq thèmes pertinents, aucun n'impliquant la recherche médicale :

1. L'utilisation inutile d'animaux vivants dans l'enseignement secondaire et universitaire, étant donné que d'autres méthodes d'enseignement sont disponibles, dont les modèles en plastique ou les animaux tués sur la route pour la dissection.
2. L'utilisation improductive d'animaux vivants dans la recherche en comportement et psychologique. Les renseignements recueillis d'une espèce ne permettent pas forcément d'établir un lien avec une autre espèce, et le comportement d'une espèce en captivité est de toutes façons anormal.
3. Les problèmes résultant, pour certaines personnes, de travailler dans un endroit où flottent toutes sortes de matières polluantes animales dans l'air. Dans un édifice où des animaux de laboratoire avaient été conservés dans des espaces restreints et ségrégués, plusieurs personnes, dans d'autres endroits de l'édifice, exposées au même air, ont développé des allergies et sont tombées gravement malades.
4. Le lien historique et actuel entre les femmes et le traitement des animaux par les hommes. Les femmes sont caractérisées, dans la plupart des sociétés, comme des personnes qui prennent soin d'autrui. Elles ont été à l'avant-garde du mouvement de protection des animaux, tant pour trouver des groupes réactifs que pour les soutenir (membres actuels des groupes de protection/des droits des animaux).
5. Les sciences et la médecine sont fortement dominées par les hommes et ne se sont généralement pas montrées trop sympathiques à l'égard du mouvement pour la protection des animaux. Plus les femmes entrent dans les sciences et plus on peut s'attendre à ce que les droits des animaux soient pris en compte et à parvenir à une société plus humaine. Étant donné que les sciences sont de plus en plus considérées comme un domaine humain, elles devraient attirer un plus grand nombre de femmes.

Le document de recherche est disponible auprès de l'auteure.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Animal Rights and Biology Practice

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This submission will consider ways to reduce the use of laboratory animals in university teaching and in research on animal behaviour. It will focus on five relevant facets, none of which involve medical research:
1. The unnecessary use of live animals in high school and university teaching, since alternate methods of teaching are available, including plastic models or roadkills for dissection.
2. The unproductive use of live animals in behavioural and psychological research. Information about one species does not necessarily pertain to another, and the behaviour of a species in captivity is abnormal in any case.
3. The emerging problems for some people of being in a space where the air contains dander or other animal pollutants. In one building where laboratory animals are kept in a small segregated area, several people elsewhere in the building but exposed to the same circulating air have developed allergies and become seriously ill.
4. The historical and present connection between women and the humane treatment of animals. Women have been socialized in most human societies to be especially caring of other beings. They have been in the forefront of the animal protection movement, both in founding reactive groups and in supporting them (current membership of animal protection/rights groups).
5. Science and medicine are heavily male-dominated and have generally not been sympathetic to the animal rights movement. As more women move into science, it is to be hoped that more attention will be given to animal rights, thus producing a more humane society. As science is seen as more humane, it should attract more women.

Paper available from the author.

MENTORING FOR WOMEN IN ENGINEERING
A CASE STUDY

Sarah J. Dench and Karen B. Levine

Un programme de mentorat a été mis en oeuvre en septembre 1991 par la Division for the Advancement of Women in Engineering and Geoscience (DAWEG) de l'Association of Professional Engineers and Geoscientists de la Colombie-Britannique. Le programme a été mis en oeuvre conjointement avec le Project for Women in Engineering de la Faculty of Applied Science de l'Université de Colombie-Britannique. L'objectif principal de ce programme était de fournir un système de soutien aux femmes dans le génie. Les participantes et participants étaient des élèves-ingénieures et élèves-ingénieurs de premier cycle et des ingénieures pratiquantes, dont des ingénieures en formation, ainsi que des ingénieures et ingénieurs professionnels. Quatre réunions structurées ont été tenues entre les mois d'octobre 1991 et d'avril 1992; un souper de présentation, une réunion d'orientation, un atelier réservé aux mentors et un atelier réservé aux protégées. Les réunions ont été animées par une conseillère ou un conseiller possédant une vaste expérience en dynamique et communications de groupe. Un soutien constant a été fourni aux «couples» par le biais d'un bulletin et de consultations individuelles. Le nombre de participantes a passé à 80, certaines jouant le rôle de mentor et de protégée en même temps. Le temps et les ressources requis pour administrer un programme de cette envergure avaient été sous-estimés. L'important, toutefois, c'est que ce projet a permis d'acquérir une certaine expérience pratique en matière d'élaboration d'un programme de mentorat à l'intention d'un groupe spécifique de femmes. Les réactions des participantes étaient généralement bonnes, avec un encouragement surprenant pour fournir une meilleure structure pour les couples mentor/protégée. Parmi les bénéfices du programme, notons l'expansion à d'autres groupes intéressés, tant dans l'APEGBC qu'ailleurs au sein de la province, et un engagement solide des participantes du programme à l'égard du développement professionnel des femmes dans le domaine du génie.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

MENTORING FOR WOMEN IN ENGINEERING: A CASE STUDY

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ABSRACT

A mentoring program was initiated in September, 1991, through the Division for the Advancement of Women in Engineering and Geoscience (DAWEG) of the Association of Professional Engineers and Geoscientists of British Columbia. The program was implemented jointly with the Faculty of Applied Science Project for Women in Engineering at the University of British Columbia. The major goal of the program was to provide a support system for women in engineering. Participants were senior undergraduate engineering students, and practising women engineers including engineers in training (E.I.T.s) and professional engineers (P.Engs.). Four structured meetings were held throughout the period of October, 1991 to April, 1992; an introductory dinner, an orientation meeting, a menfor-only workshop, and a protege-only workshop. The meetings were facilitated by a consultant with extensive experience in group dynamics and communications. Ongoing support was provided to pairs by newsletters and one-on-one consultations. Participation grew to a total of 80 members, with some participants acting as both mentors and proteges. The time and resources required to administrate a program of this size were underestimated. This provided first-hand experience in tailoring a mentoring program to a specific group of women. Feedback from participants was generally positive, with overwhelming encouragement to provide more structure for the mentor/protege pairs. Successful outcomes of the program included expansion to other interested groups, both in the APEGBC and elsewhere in the province, and a stronger commitment on the part of program participants toward women's career development in engineering.

INTRODUCTION

The concept of mentoring is not new, dating back to the ancient Greeks. In the last decade, formalized mentoring programs have been established in industry and professional organizations, with demonstrated benefits to mentors, proteges, and their organizations.

The positive impact of mentoring for women in professional organizations and the business community has been previously demonstrated (Collins, 1983). With this in mind,

the establishment of a mentoring program for women Professional Engineers and engineering students was undertaken as a pilot project in September 1991, drawing participants from the Division for the Advancement of Women in Engineering and Geoscience (DAWEG) of the Association of Professional Engineers and Geoscientists of B.C. (APEGBC) and from women enrolled in the senior years of undergraduate studies in Engineering at the University of British Columbia. Assumptions underlying the program were that women as an underrepresented group in engineering would experience long-term benefits to their professional and personal development, and maximize their opportunities for networking with other women in their field.

The major goal of the program was to provide a support system for women in engineering, at all stages of their careers. The recent report of the Canadian Committee on Women in Engineering (1992), *More Than Just Numbers*, stated that one of the barriers to retaining women in the field at all levels was lack of adequate support systems, and related feelings of isolation. Further, that report suggested that strengthening connections between students and the professional community would have a beneficial impact on women in engineering, ensuring that women and men would have equal access to 'learning the ropes', and thereby reduce the attrition rate of women from the profession. Establishment of the DAWEG/UBC Mentoring Program was in response to the members of DAWEG expressing the desire for such support, and the desire to assist women in the sometimes difficult transition from student to Engineer in Training. DAWEG members also wished to minimize their experiences of isolation on the job; often being the only woman Engineer in an office or company made networking with other professional women difficult.

DESIGN OF THE PROGRAM

In August 1991 plans for the mentoring program were developed. Potential participant groups were identified, and an information meeting was held in October. At that meeting, those interested were provided with information about mentoring, and about the benefits of participation in a formal program as opposed to happenstance mentoring. The deadline for applications to participate as mentor, protege, or both, was one month after the information meeting.

Applications were in questionnaire form, and were filled out by all prospective participants. Included was information on discipline of study in engineering, year of (expected) graduation, preferred frequency and location of meetings, reasons for participation in the program, and other hobbies and interests.

Area of specialization in engineering was the primary criteria used by coordinators for matching mentors and proteges. Where a fit by discipline was not available, pairs were matched by common interests and hobbies. All participants were informed of who they were paired with, and the mentors were given the responsibility of initiating the first contact with their protege. Coordinators requested that pairs meet in-person before the orientation meeting, held in November.

The purpose of the orientation meeting was to provide basic information and training to the established pairs. Topics for this meeting focussed on communication skills and goal setting. Two additional meetings were held in the 4 months following the orientation; a mentors-only meeting, and a proteges-only meeting. These meetings provided further information on the mentoring process, and problem solving within the mentoring relationship. The two groups were asked to attend separate meetings so that

participants would be able to air problems in a setting that minimized potential embarrassment and encouraged honest discussion of problems.

All meetings in the program were led by a professional facilitator with experience in communications skills for women, and group dynamics. In the intervals between meetings, support was provided to pairs in the form of newsletters, and one-on-one consultations with the coordinators. No meetings were held between May and September as many participants were unavailable. However, regular updates were sent to participants as a means of ensuring continuity until the program formally resumed in September 1992.

PARTICIPANTS AND ISSUES

The program's initial enrollment was 25 pairs, and 5 unmatched proteges. However, once a core group of women were involved, the program grew quickly by word-of-mouth. At the end of the first year of the program 40 pairs were established, and in September 1992, 18 pairs renewed their mentor/protege pair for another year. Enrollment in the second year of the program increased to 47 pairs, with an additional 10 to 15 women enrolling after the application period in September.

Feedback from participants in the first year indicated that they found the mentoring relationship to be beneficial both professionally and personally. Participants reported that they valued the opportunity to ask career questions in a nonjudgemental, 'safe' way, and that learning about someone else's work and work environment provided a fresh perspective. Further, job search assistance had been provided via the program network. Examples of pairs activities included successful salary negotiation, polishing interview skills, and resume writing.

Participants indicated that although they found the program highly beneficial, more structure was required to assist in establishment and maintenance of a relationship, and to develop realistic goal-setting strategies. The initial stages in the development of the relationship were found to be the most difficult, and further program materials, such as sample scripts for first phone calls and suggestions for ice-breaking activities, were developed to assist participants in moving though that phase of the relationship.

A problematic issue for some women was dealing with unsuccessful matches. The coordinators had emphasized throughout the program that participants could opt for a 'no-fault' conclusion to their matches. This proved to be easier said than done; particularly in pairs with younger participants, when one individual felt that the relationship was not productive they had a difficult time ending the relationship for fear of offending the person they were matched with. This situation had not been mentioned in the literature on mentoring, which dealt primarily with mixed-gender mentoring relationships. If theories of women's focus on preserving connection and maintaining relationships (eg. Gilligan, 1982 and Belenky, Clinchy, Goldberger and Tarule, 1986) hold true, this may be one possible explanation of the reluctance of participants in an all-women mentoring program to sever relationships.

Throughout both the pilot year and the 1992-93 program, there was an imbalance between the number of mentors and proteges available. Coordinators frequently had to recruit, using both the program network and that of APEGBC, in order to meet the demand for mentors. It was particularly difficult to find potential mentors at the senior level (with more than 10 years of experience in industry) to mentor women with 7 or more years of

professional experience. Program coordinators anticipated that this would continue to be a problem until more women advance through the professional ranks.

OUTCOMES AND FUTURE DEVELOPMENT

The DAWEG/UBC Mentoring Program was regarded as successful, as measured both by feedback from participants, by an increase in the number of participants from the first to second year, and by inquiries from other organizations interested in the program model (for example, organizations ranging from other branches of the APEGBC to the Federal government). Students, in particular, have expressed an interest in making the program available to students in earlier years of study. However, the coordinators have decided that this is not feasible due to the current demand for mentors outstripping the number available. Also, the benefits to all participants are maximized by ensuring that mentors and proteges have enough experience in engineering to have formed realistic career goals.

Coordinators continue to seek senior women mentors for proteges currently enrolled. It is also hoped that proteges will themselves become mentors as they gain more professional experience. Although this may not happen directly through a formalized program, the long-term impact of involvement in this program could encourage women to seek out mentoring from other women, and seek other women to mentor.

It is anticipated that the program will continue to grow and improve. The growth will come primarily as a result of word-of-mouth; many new applicants for the program have commented that they waited Until the 1992-93 year to apply, to both see how the program developed, and to ensure that a program designed to benefit women was not 'stigmatized' as feminist! The majority of women in the program have expressed their

appreciation of the fact that the program is designed for women only, and have demonstrated an increased commitment to women's career development in engineering through their interest in other issues, such as child and family care policies and sexual harassment in the workplace.

As mentioned above, the DAWEG/UBC Mentoring Program has drawn attention from other organizations, both in engineering and elsewhere. This program has been unique in that it has demonstrated the benefits of formalized mentoring in a short period of time, within a specific profession, and not defined by one company or workplace. As a result, it is a useful model for professional organizations and similar groups wishing to provide their members with additional support and development opportunities.

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BUILDING THE CONFIDENCE OF WOMEN ENGINEERING STUDENTS: A NEW COURSE TO INCREASE UNDERSTANDING OF PHYSICAL DEVICES

Debra A. Desrochers, Jerald M. Henderson and Karen A. McDonald

Pour faire face au taux croissant d'abandon des femmes dans les cours de génie de division inférieure et au petit effectif féminin dans les écoles d'ingénieurs, tant à l'échelle du pays qu'en Californie, le College of Engineering de l'University of California, Davis (UC Davis), a ouvert un centre pour les femmes dans le génie. Le centre bénéficie de deux subventions, dont une de la National Science Foundation (NSF), pour organiser des activités visant à encourager le maximum de femmes à faire leurs études de premier cycle dans le domaine du génie, et l'autre du Fund for the Improvement of Post Secondary Education (FIPSE), pour mettre sur pied des activités des niveaux du jardin d'enfants à la 12e année (K-12) visant à encourager davantage de femmes à se lancer dans des carrières des secteurs des sciences et du génie.

Avec le soutien de la NSF, on a conçu et mis en oeuvre un programme à l'intention des femmes visant à les aider à surmonter les craintes et l'intimidation associées à la compréhension et à l'utilisation d'appareils mécaniques et électriques. Introduction to Physical Devices and Systems, un cours à deux unités conçu pour les femmes des programmes de génie de division inférieure, a été enseigné par une équipe de cinq personnes : un instructeur et quatre adjointes à l'enseignement (ingénieures diplômées), qui ont également servi de modèles à dix-huit étudiantes et étudiants qui terminaient ce programme très en vogue. Le programme mettait l'accent sur des activités d'apprentissage pratiques, indéterminées et d'équipe visant à exposer les étudiantes et les étudiants au matériel, aux concepts sous-jacents et aux méthodes de travail avec ces systèmes, ainsi que sur quelques questions de nature philosophique. Ce programme a eu un impact positif sur toutes les participantes et tous les participants et est actuellement en cours d'évaluation et de révision pour éventuellement être donné à nouveau. En outre, les fonds du FIPSE permettent actuellement d'adapter les activités du programme pour les élèves de la 12e année.

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BUILDING THE CONFIDENCE OF WOMEN ENGINEERING STUDENTS: A NEW COURSE TO INCREASE UNDERSTANDING OF PHYSICAL DEVICES

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Abstract

To address the growing concern over both the attrition rate for women in lower-division engineering programs and the small percentages of women in the engineering school population, both nationally and in California, the College of Engineering at the University of California, Davis (UC Davis), established a center for Women in Engineering. The center received two grants, one from the National Science Foundation (NSF) to develop activities to retain more women in engineering undergraduate programs, and one from the Fund for the Improvement of Post Secondary Education (FIPSE) to develop activities for the kindergarten through twelfth grade (K-12) levels that would encourage more women to choose science and engineering careers.

With the support of NSF, a course to overcome women's anxiety about, and intimidation in understanding and using, mechanical and electrical devices was designed and implemented. *Introduction to Physical Devices and Systems*, a two-unit course for lower-division women in engineering, was taught by a team of five: a male instructor and four female teaching assistants (engineering graduate students) who also served as role models for the eighteen students who completed the popular course. The course emphasized hands-on, open-ended, cooperative learning activities to expose the students to hardware, to the underlying design concepts, and to procedures for working with these systems. The women kept journals of their observations during the course. The course was balanced by discussion of issues relevant to women in engineering, such as gender equity in the classroom, and by guest speakers -- role models who are practicing engineers.

The authors' observations and the students' responses to the course are summarized. The students reported that the course gave them confidence and helped them establish a supportive female engineering student network. The instructor, an experienced professor in the College, noticed distinct differences in teaching an all-women class. The course also brought some philosophical issues into focus. It had a positive impact on everyone involved, and it is being evaluated and revised for a second offering. In addition, with funding from FIPSE the course activities are being adapted for the K-12 levels.

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[1] Desrochers was a teaching assistant, Henderson was the instructor, and McDonald was the principal investigator of the NSF grant for the course.

A significant number of women in the College of Engineering at the University of California, Davis (UC Davis) have chosen engineering as a profession -- 18.5 percent of the undergraduates, 15 percent of the graduate students, and 7 percent of the tenure track faculty. In addition, there is a well-established campus network for women in math and science-based fields. With these strengths as a foundation, the College established a center for Women in Engineering to address the growing concern over both the attrition rate for women in lower-division engineering programs and the small percentages of women in the engineering school population, both nationally and in California. Some of the goals of the center include increasing the number of women completing engineering degrees at UC Davis, encouraging research on issues of gender in engineering and the natural sciences, identifying institutional barriers to women's success in engineering and advocating policy to eliminate these barriers, examining the problems typically encountered by female engineering and science students at all levels of the educational endeavor, and developing and evaluating programs at UC Davis that effectively foster the skills women bring to engineering, identifying the unique contributions they can make.

The center received two grants, one from the National Science Foundation (NSF) to develop activities to retain more women in engineering undergraduate programs, and one from the Fund for the Improvement of Post Secondary Education (FIPSE) to develop activities for the kindergarten through twelfth grade (K-12) levels that would encourage more women to choose science and engineering careers.

The Experimental Course

With the support of NSF, a course has been designed and implemented to overcome women's anxiety about, and intimidation in understanding and using, mechanical and electrical devices. *Introduction to Physical Devices and Systems*, a two-unit course for lower-division women in engineering, was taught by a male instructor and four female teaching assistants (engineering graduate students) who also served as role models. Hands-on, open-ended, cooperative learning activities were emphasized to expose the students to hardware, to the underlying design concepts, and to procedures for working

with these systems. Eighteen students representing a broad cross-section of majors in the College of Engineering completed the course.

The weekly lab experiences were designed to keep the students actively exploring concepts with their hands and minds. During labs, these women became familiar with hand tools; made a nut; took their bicycles apart and reassembled them; made an electronic cricket using breadboards and soldering tools; took apart, examined and reassembled a one-cylinder, four-stroke engine; built sections of a wooden truss designed to support the weight of all the class members; and disassembled a car. They also completed small and large projects in which they explored machines of their choosing, taught themselves how these machines worked, and presented their findings to the rest of the class. The small projects were done by pairs of students, and included an electric shaver, a cassette player/recorder, a toaster, a compact disc player, a manual typewriter, a hair blow dryer, an electric drill, automobile steering, and automobile brakes. The large projects were completed in groups of four (with one exception), and the items studied were a refrigerator, a washing machine, a copying machine, the car transmission, and an electronic typewriter (group of two students). The presentations of these projects were held during both the discussion and the lab periods. Tours of the college machine shops and the campus bowling alley to learn how pin setters work were included in the labs.

Out-of-class assignments included reading articles on the climate for women in engineering and assignments in the text, David Macaulay's *The Way Things Work*. The students were sent to a local fitness club to compare two types of exercise machines. One other "field trip" was to a local hardware store to find ten "machines" there and identify how they worked. Finally, the students were asked to go home with their tool kits and report to the class how their toilets and door knobs worked.

The course was balanced by discussion of issues relevant to women in engineering, such as gender equity in the classroom, and by guest speakers – female role models who are practicing engineers. The guest speakers included the teaching assistants for the course, a self-employed environmental engineer, and a mechanical engineering doctoral student who had designed some of the exercise equipment that the students studied at the fitness center.

Course Evaluation

For evaluation of the course, the women kept journals of their observations during the course. They were asked to be personal in their writing, which is unusual for an engineering class, and to include the following comments in their journals regarding each activity:

- What did I like least/most?
- What did I learn about myself and my skills?
- How can the activity be improved?
- Any related thoughts.

The students' journals, and interviews of the professor and teaching assistants formed the basis for evaluation of the course. The course has been evaluated using case study methodology. According to the project evaluator, a person hired specifically for this task, a number of themes echoed throughout the data. These included the concept of the "chilly climate" for women in engineering; the impact of female role models during the course; and evidence of increased confidence, self-knowledge, and skill building. Additional themes were communication differences between men and women; and whether men should be allowed in the course, and what their impact might be. The topics explored in this paper include evidence of increased self-esteem, persistence, and scientific curiosity among the students, which were course goals, and a discussion of whether the course should be limited to women.

Evidence of Increased Self-Esteem and Persistence

The students reported that the course gave them confidence and helped them establish a supportive female engineering student network. According to the project evaluator, although there was a range of experience and interests among the students, there were comments in each student's journal that indicated that they enjoyed the class, felt more confident about hardware, benefited from role models, and felt encouraged to pursue an engineering career. Some of these comments include:

- "In general, this course encourages me to continue pursuing the career of engineering. It shows me the fun side of engineering in comparison to the side of principles and

concepts of things. It also shows me how those concepts and principles are applied to things."

- "I really enjoyed the class. I believe it has helped my performance in my other classes. Not only has this class taught me a lot about how things work, but it has also taught me how to figure it out for myself which helped me to learn how it worked better."
- "On the whole, I truly loved this class. It offered an insight into stuff I never had an opportunity to deal with before E-25 (the course number). I feel more aware of engineering and how it applies in real life. I have missed that understanding in the past. My lack of info. about what engineers really do almost turned me away from the major because I only witnessed the hard courses."
- "E-25 certainly was enjoyable...I truly learned about who I am. The class (has) been supportive. I (got) the encouragement I needed to stay in engineering."
- "I really benefit(ted) from taking this course because now I actually feel more confident about myself and about becoming an engineer. I know that women can become great engineers...and I'll never let someone else tell me otherwise."

Development of Scientific Curiosity

One student stopped by the professor's office one day a few months after the course had ended to tell him about fixing her car door lock. After locking her keys in her car, calling an automobile club, and watching them ruin her lock, she was actually jumping up and down in the hall with excitement as she told him about fixing the lock herself.

One student from the course who previously had no hands-on hardware experience has been included in a hybrid electric vehicle project that previously had only been offered to seniors. The group is building a car for a race in June sponsored by Ford and the Society of Automotive Engineers.

Finally, excerpts from student journal writings on the development of their scientific curiosity include:

- "I have enjoyed this class a lot. The desire to figure out how things work and to rip them apart has been enlarged greatly...Honestly, this class has kept me interested in Engineering as the quarter has gone. I've been frustrated with other classes and

plowed on through simply because I had so much fun playing (with) engines in E-25!...This has been a quality class & lab."

- "I enjoyed this class. Not only did I become familiar with tools and some basic appliances, I gained the confidence to look at other machines around me....Although it wasn't the goal of the class, I also made some good friends...It's been fun and definitely interesting. Thanks."

Should Course be Limited to Women?

The course also brought some philosophical issues into focus for those involved. For example, should this type of course be limited to women? If the course were co-educational, would its effectiveness in increasing the confidence of women engineering students be diminished? A third of the students discussed this in their journals. The evaluator summarized that while two students observed that not only females experience ignorance about hardware, and that the exclusion of males is "pure discrimination," all those who wrote about it thought that having male students in the class would change the experience. They felt they would act differently and not feel as free; that the males would group together, leaving the females feeling "isolated;" that women would not feel as free to share their feelings or experiences of discrimination; and that they would not bond or form friendships of the same intensity. One student noted in her journal, "I really don't think that this class would click if there were even one guy in it!"

Because the course is experimental, the University is able to justify offering it only to women. Data are needed to document whether involving men in the course would dilute the experience for women. Case studies of different course situations must be studied -- for example, men and women students together in the course, and women students with male teaching assistants.

Resulting Investigations and Observations

The course had a positive impact on everyone involved, and it is being revised for a second offering in 1993. The revisions to the course for 1993 and the future of the course are discussed here as well as adaptation of the course activities for primary and secondary schools, and anecdotes on teaching an all-woman class.

Revisions to Course for 1993

The revisions being considered for the course for its second offering, as compiled from suggestions by the students, professor, teaching assistants, and project evaluator, include:

- Using name tags and an address/phone list at the beginning of the course to create a relaxed and interactive classroom environment.
- Structuring the labs more tightly so that each student benefits equally from the various hands-on activities.
- Establishing more interaction between the teaching team and the evaluator, and designing instruments to measure student attitudes toward the course material before and after exposure.
- Giving the students more guidance regarding how to use their notebooks, especially the development of their glossary of terms, and writing about their observations.

The students will again be encouraged to freely write their observations about each course activity in their notebooks. However, this class will be asked questions designed to explore the themes of the first class in more depth, to have data to compare student responses, and to encourage the students to make journal entries more consistently. Some example questions are:

- How do you feel about what you read (regarding an article on women in engineering)?
- What caused you to decide you wanted to study engineering?
- Describe your mental image of an "engineer." Do you fit that image?
- Do you want a professional career as an engineer? Have you considered yet whether you want a family? Are these compatible goals for you?
- Who supports or encourages you in your educational/engineering career pursuits? How do they support or encourage you? Do you have a role model(s) or mentor(s)? If so, who are they?
- Observe, and describe, a difference in the way men and women communicate in one of your classes or labs. What was the difference, and what was your reaction?
- How would this class be different if men were in it? Describe.

•Should men be allowed to take this class? Give views that are pro and con, then state your own view and why you think this. Has your opinion changed over time? Explain.

Future of Course

Future course evaluation considerations include staging a focus group of students who have taken the course to examine whether they have any long-lasting attitudes and beliefs as a result of the course. Also envisioned is the implementation of a simple evaluation procedure for future offerings of the course to ensure that its impact on female engineering students may be studied over the long-term. Additionally, the project team is aware that similar courses have been or will be taught on a few other university campuses. Consultation with the instructors of these other courses is planned to see if and how the courses are being evaluated, and if they can be compared in any systematic way to "How Things Work" at UC Davis.

It is desired that this course become a permanent addition to the curriculum of the College of Engineering at Davis. To achieve this, the number of units may be increased. Also, to insure the course's effectiveness in its original purpose when it is opened to all students in the College of Engineering, additional sections must first be studied, with different gender combinations of students, instructor, and teaching assistants.

Adaptation of Course Activities for Primary and Secondary Schools

With funding from FIPSE, the course activities are being expanded for use by primary and secondary school science teachers. A pilot workshop instructing primary science teachers in the San Juan Unified School District, Sacramento, CA, in the principles and activities employed in the course has been completed, and additional teacher training workshops to disseminate these techniques have been designed and will take place this year.

Teaching an All-Woman Class

The instructor, an experienced professor in the College, noticed distinct differences in teaching an all-woman class. The students felt comfortable in his presence, and easily approached him in class and in his office, joked around with him, and keep in touch with

him. He even noted that women say "thank you" every day as they leave a lab -- men never do that!

At the end of the quarter, he gave each of his students a carnation, and told them to be proud of being women. At the same time, he also asked the students to keep in touch with him. Many students have kept in touch, whether by saying hi when they pass him on campus, or actually stopping by his office for a chat.

Acknowledgments

The authors wish to acknowledge and thank for their help and interest in this course: NSF, for funding the development and implementation of the course; FIPSE, for funding the adaptation of the course activities for primary and secondary schools; Wendy Feenstra, Veronica Cano, and Sharon Erney, teaching assistants; Mary Margaret Bland, the evaluator; and Robby Henes, Jane Elliott, and Jeannie Darby, for their support and guidance.

HELPING TEACHERS MAXIMIZE THE LEARNING OF FEMALE STUDENTS

Patsy Ann Giese, Ph.D.

Les enseignantes et enseignants peuvent largement influencer les étudiantes pendant les années critiques de leur adolescence, où elles prennent toutes sortes de décisions importantes pour leur avenir. Cet article décrit un cours du niveau supérieur conçu pour d'aider les enseignantes et enseignants des paliers élémentaire et secondaire à comprendre les causes et les conséquences de la sous-représentation des femmes dans les domaines d'études scientifiques et mathématiques et à accroître leur volonté et leur aptitude à modifier ce statu quo.

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HELPING TEACHERS MAXIMIZE THE LEARNING OF FEMALE STUDENTS

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ABSTRACT

Teachers can influence female students during the critical adolescent years in which girls are making decisions that may affect their futures irrevocably. This paper describes a graduate course developed to help elementary and secondary teachers understand the causes and consequences of underrepresentation of women in scientific and mathematical endeavors and then to increase the teachers' willingness and ability to change the status quo.

INTRODUCTION

Although it is widely believed that peer pressure is the dominant factor that influences teenagers, an American Association of University Women survey showed that adults have greater impact than peers. In a factor analysis, feelings of acceptance by peers ranked below academic confidence as a dimension of adolescent self-image. Academic pride was a more important aspect of self-esteem for girls than for boys. This survey also found that liking math and science had a stronger impact on girls' desire for a professional career than boys'. Young women's feelings about academic performance were found to be strongly correlated with their relationships to teachers. "Thus, teachers have a special opportunity to affect the self-esteem of their female students, and, by instilling confidence, to shape their interests and aspirations" (AAUW,

1991).

In order to help science and mathematics teachers maximize the learning of female students, I have taught a three-credit (40 in-class hours) graduate course four times at Slippery Rock University of Pennsylvania from 1988 to 1990. A total of 122 teachers of fifth grade through twelfth grade completed this course. The ratio of male teachers to female teachers was 42/80. They drove up to 190 miles per round trip to attend. A survey of the last class of participating teachers showed that the largest group (35%) became aware of this opportunity through a recommendation by a teacher who had already taken this course.

As this course was taught repeatedly, the most effective portions were refined while substitutions were made for the less effective portions. Tuition was paid by funds granted under the federal Education for Economic Security Act and the Dwight D. Eisenhower Mathematics and Science Education Act. Jim Hirstein, a mathematics professor at the University of Montana, was co-director with me for the initial session. The next three times the course was taught, I was the sole director. Another grant proposal has been written requesting funding for this course from 1993 through 1996. Co-director for this coming cycle will be Dale Hunter, a biology professor at Edinboro University of Pennsylvania.

The following concerns about conditions in the United States led me to develop the course described in this paper:

1. smaller numbers of females than males enrolled in elective high school science and mathematics courses,
2. disparities in achievement between males and females in science and mathematics as measured by standardized tests,
3. lower expectations of females for themselves as compared to their male peers,
4. a decline in career commitment of females who felt men disapproved of women using their intelligence,
5. the underestimation by girls and their teachers concerning the length of time females, on the average, have paid employment,
6. the concentration of women in very few occupations out of tens of thousands of possibilities,
7. the decreasing numbers of women entering technical professions (occurring after more than a decade of fairly rapid increases),
8. the high rate of poverty for female heads of households.

Believing that major change only happens incrementally as individuals change their values and actions, I was not discouraged by the magnitude of these problems. Instead, I decided that my efforts to affect teachers in Western Pennsylvania would be a positive, albeit small, influence on American society. Presumably, each teacher who took the course could then affect hundreds of students.

COURSE DESCRIPTION

Several principles undergirded the development of this course.

First was the assumption that genetic differences in the brains of males and females are insignificant (and possibly nonexistent) causes of the differences in numbers of males and females engaged in scientific and mathematical endeavors as a part of their education, recreation, and employment. However, messages given though family interactions, exposure to advertising, and other common situations convey the impression that characteristics needed for learning science and mathematics--such as curiosity, persistence, and intelligence—are not characteristic of females. Schools need to be exceedingly careful that these messages do not creep into their hidden curriculum.

Another principle of this course was idea that being able to picture oneself accomplishing tasks is essential for enthusiastic and confident learning. Dynamic role models should be provided for young females though the use of print and audio-visual materials supplemented by contact with adult women, particularly those who use science and mathematics.

Third was the principle that, for meaningful learning, abstract ideas need to be related to tangible objects and observable phenomena. Because girls often have been more restricted than boys in playing with a wide variety of objects, girls need to be given numerous opportunities to use manipulative/hands-on materials in schools.

During this course, substantive discussions were facilitated by the requirement to read as many as five textbooks and several articles. (In

the proposal currently being considered, eleven textbooks were requested for each participating teacher.) Emphasis was on research-based strategies such as cooperative learning that have been shown to increase motivation and achievement of girls. Ways to lessen mathematics and science anxiety were also explored. Research findings about classroom interaction patterns were related to incidences in the participants' own classrooms.

Some of the textbooks provided activities that teachers could use with adolescent students. For this graduate course, class time was allotted to manipulative/hands-on activities that develop abilities generally weaker in females than in males (for example, logical reasoning and spatial visualization). Computer work was included, too, using public domain and commercial software.

The history of women who have excelled in science and mathematics was part of this course. In one lecture, I gave the teachers an overview of 5000 years of women's obstacles and achievements in these disciplines. I compiled a bibliography on this subject to facilitate the participating teachers and their students writing reports and making oral presentations on this topic.

Also, current statistics were provided about aspects of women's lives, including their education, employment, poverty, and self-esteem. A role playing game was used to illustrate that the probabilities of reaching particular levels of education and earnings are very different

for males and females. Segments of several videotapes were shown during the course to illustrate females using science and mathematics.

Guest speakers were (in most cases) valuable role models and sources of information. They provided a variety of perspectives, such as coordinating a university mathematics program for entering students, chairing a science department at a private research university, administering a large college of engineering at a public university, teaching innovative engineering and public policy courses, and directing a university women's studies program. This variety will be increased for the proposed cycle because women employed in industry have agreed to speak. The teachers enrolled in my course appreciated the fact that guest speakers were willing to discuss their own education and other personal experiences. My scheduling of female guest speakers was intended to motivate the participants to do likewise in their own classrooms. (That expectation has been fulfilled.) Male guest speakers spoke to my graduate classes, but--with one exception--their presentations were not worthwhile.

The participating teachers gave oral presentations and/or completed written assignments each time I taught this course. They did this individually or in cooperative groups. They had the following options:

1. a unit plan that meets the Criteria for Equitable Activities published by the American Association for the Advancement of Science,

685

2. a research report based on interviews or questionnaires either with adolescents or adults learning/using science and/or mathematics,
3. a research report based on analysis of sex role stereotyping in textbooks or mass communication media,
4. a book report on an autobiography or a biography of a scientist or mathematician,
4. a book report on a history of science and/or mathematics,
5. a book report on a summary of recommendations based on results of education research.

Each of the above categories was chosen by at least one participant. Particularly outstanding were a female-friendly unit on bridges taught to middle school students, videotaped interviews of math-anxious women attending a vocational/technical school, and a report on Rachael Carson using published political cartoons as well as a biography.

EVALUATION

Through taking this course, teachers became more sensitive to equity issues. A Likert-type attitude questionnaire was developed by Jim Hirstein and myself, and it was administered during the first and last class periods of each session. For each of the four times the course was taught, there were significant differences ($p < .01$) from pre- to post-testing on each of the five scales for this questionnaire with the exception of the "teaching science" scale for the fall 1989

group ($p = .016$). Female teachers had more favorable attitudes than male teachers as measured by the "interacting with females" scale. On the average, men's scores at the end of this course were slightly higher than women's initial scores. Besides that, the increase for women was greater than the increase for men.

Favorable responses were obtained from participants on a 15-question form about the quality of the program. This Likert-type instrument was based on a form devised for another in-service program conducted at several universitites in Pennsylvania. All statements were positive, and the ratings were coded from one for strongly disagree to five for strongly agree. Given chronologically for the four times I taught the gender equity course at Slippery Rock University, the means for the entire instrument were 4.43, 4.16, 4.53, and 4.64. Jim Hirstein taught with me the summer of 1988, so the first mean reflects his efforts as well as mine.

Participants praised the course on a student evaluation form required by Slippery Rock University and on another form written by me. Also, fourteen male and female participants wrote complimentary letters to me (with two letters being sent also to Pennsylvania Congressmen and Department of Education officials).

CONCLUSION

During this gender equity course, participants were exposed to ideas and given tangible resources in order that these teachers could be

agents of change in their own environments. Responses to a questionnaire (pre- and post-course) as well as discussion at a follow-up meeting showed that participants were using strategies and activities from the program in their classrooms. Before the course, 8.5% of the teachers were implementing strategies for maximizing the learning of female students using print and audio-visual resources and manipulative/hands-on materials. Months after the course, that number had increased more than nine-fold to 80.0%.

In addition, participants were influencing other teachers and administrators to be concerned about female participation in science and mathematics activities. Many participants shared articles, books, and software with other teachers in their school districts. A few female participants gave presentations about gender equity for faculty in-service sessions, parent meetings, community organization meetings, and regional professional conferences. One male participant submitted his gender equity unit plan for a state-wide competition.

The real measure of success for this course is not the teachers' activities, but their female students' life-long learning. That effect cannot be documented. I do believe my efforts have brought some adolescents closer to gaining the best possible future for themselves.

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AN EXPERIMENT IN FEMALE FRIENDLY CHEMISTRY

Catherine Gillbert

Ce document décrit une expérience conduite dans un collège du Québec, à laquelle ont participé toute une équipe d'instructrices et instructeurs, qui avait pour but de modifier l'attitude des étudiantes à l'égard de la chimie et de l'industrie des produits chimiques et d'encourager ainsi plus de femmes à poursuivre leurs études universitaires dans les domaines des sciences physiques ou appliquées. Le groupe expérimental était composé de quatre enseignantes et enseignants et de cinquante-deux étudiantes. L'expérience a démontré que, dans au moins un collège, on a été en mesure de rehausser l'intérêt des étudiantes à l'égard du contenu d'un programme de premier niveau, de modifier l'attitude des étudiantes vis-à-vis de la chimie et de l'industrie des produits chimiques et d'encourager certaines étudiantes à envisager une carrière dans les secteurs des sciences physiques ou appliquées.

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689

AN EXPERIMENT IN FEMALE FRIENDLY CHEMISTRY

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ABSTRACT

This paper describes an experiment carried out in a Quebec college, involving a team of instructors, that attempted to change the attitude of female students towards chemistry and the chemical industry, and, thus, encourage more women to continue their education in the physical or applied sciences at the university. The experimental group involved four teachers and fifty-two female students. The experiment showed that, at one college, it was possible to increase the interest of the female students in the content of a first level course, to change the attitude of female students towards chemistry and the chemical industry and to encourage some female students to consider a career in the physical or applied sciences.

INTRODUCTION

The educational system in Quebec differs from that of any other North America and this provides us with a unique perspective on the causes of the under-representation of women in the physical and applied sciences at the university level and possible ways of ameliorating the problem. In Quebec, all students who graduate from high school and wish to continue their studies at the university, regardless of their area of interest, must first attend a *collège d'enseignement général et professionnel*, commonly known as a cégep, for a two year course of study that culminates in the awarding of a *diplôme d'études collégial*, a DEC. This system has proved to be beneficial to women in many ways but it has not been able to address the problem of female students' lack of interest in the nontraditional sciences.

The cégep system was established in 1967 as a result of the recommendations of the Parent Commission, a royal commission that looked into the problems of education in Quebec. Many historians have seen the

establishment of the Parent Commission (Government of Quebec, 1964) as the single most important event of the Quiet Revolution, the period of radical change that swept the province in the late 50's and early 60's. Its effects on Quebec society include the rise of nationalism; the reduction of the power of the Catholic Church; the reorientation of the francophone education system to produce specialists in science and business, which has resulted in francophones becoming the majority amongst the leaders in the industrial and commercial development of the province; and a series of legislative acts designed to ensure the preeminence of the French language within the province.

Although there is no evidence that the authors of the Parent Commission Report were concerned with the any of the gender inequalities within the province's educational system, many of the briefs presented to the Commission from women's organizations pointed out that francophone girls were being educated in poorly equipped and poorly staffed institutions, and administered by orders of nuns, which were denying them access to a modern education (Jean, 1974). However, it is undeniable that the establishment of the cégeps, free post-secondary institutions spread throughout the province that are accessible to all, resulted in a rapid increase in the number of young women receiving a college education. By the end of the 1970's, women made up half the student body of the cégeps and now they comprise 55%. They are also higher achievers; they pass their courses at a higher rate (Corriveau, 1991). Gender inequalities still exist, however; for example, women are still under-represented in the student body in the nontraditional professional programs, such as those that train electricians and aircraft maintenance personnel (Rheaume, 1985).

Within the pre-university science programs, women make up approximately half the student body and here, too, they pass their courses at a rate equal to, or higher than, male students (Rouleau, 1985). Recent reports from both the rest of Canada, (Connelly et al, 1989) and the United States (Educational Testing Service, 1989) have shown that the gender gap in science achievement among high school students is closing, and in Quebec, perhaps because of this unique system of education, the gap at the college level has

disappeared. But these capable and well-educated young women are not choosing to pursue science careers in the physical sciences or engineering at a rate any higher than that in other jurisdictions in North America. It appears, therefore, that, as a result of the Quebec experience, we can no longer blame gender differences in achievement in mathematics and science as the causes of this phenomenon and we must acknowledge that the problem lies in some form of systemic discrimination. It is not sufficient that young women should have the motivation, self-confidence and encouragement to do well in their courses; it is imperative that they believe that the physical and applied sciences will offer them an interesting, rewarding career that is beneficial both to themselves and society, and in which they will be accepted as equals.

This paper describes an experiment at an anglophone cégep, Champlain Regional College in St-Lambert, Quebec, that attempted to change the attitudes towards chemistry of young women in the pre-university science program and thus make them more likely to seek a career in the physical and applied sciences. The experiment was modelled after the Girls into Science and Technology (GIST) program (Smail et al, 1984) that was implemented by the Manchester Education Authority in England. This program, carried out over a three year period, addressed some of the academic and psychological needs of 14-16 year old female students. The experiment was deemed successful since it realized its goal of getting a larger number of girls to attempt applied technology courses in the year subsequent to the intervention. Although in the cégeps students are slightly older (the majority of science students are between 17 to 19 years old), it was felt that similar interventions would be likely to be effective at Champlain College. The interventions were administered in Chemistry 101, a first level college level course.

THE PILOT STUDY

The purpose of the pilot study, carried out in the 1988-89 school year, was to develop an attitude measuring instrument that would reflect changes in attitudes resulting from the interventions.

The pilot study was of the pretest, posttest, experimental and control

group type which closely approximates a true experiment and mirrored the proposed experimental design. The experimental group comprised eighteen female students and twenty-two male students, randomly selected. A similar number of students were in the control group. Male students were also followed as it was felt to be important that any intervention should not have a negative impact on the attitudes or success rate of male students. The interventions, directed only towards the experimental group, were designed to address several of the factors believed to contribute to girls' more negative attitudes to science.

The proposed interventions followed as closely as possible the model of the GIST project, taking into account the fact that cégep instructors have considerably more autonomy than do teachers in most high schools. The interventions included the provision of role models, the introduction into the curriculum of material of particular interest to the female students and some exercises designed to improve visual-spatial perception.

Almost all the literature on this topic discusses the lack of role models as one of the causes of the problem. This was addressed in two ways. Profiles of several women chemists doing research in Canadian universities on aspects of physical chemistry that were directly related to the course were included in the lab manuals. These profiles included not only a brief description of the research achievements of the women, but also personal details, such as their family situation and their hobbies. The purpose was to present them as well-rounded people as well as scientists, with a rewarding life both inside and outside the laboratory. Also included in the manual were profiles of several women working as chemical engineers in international organizations within Canada. Again, the profiles included both a description of the type of work they did, their education, work related experience and career goals, and a brief description of their hobbies and family life. Needless to say, all the women who agreed to become involved were enthusiastic about their work and about encouraging other women to follow in their footsteps. In addition, two young women chemical engineers working in local industries were invited to come and talk to the classes about their work.

In order to develop a curriculum that was more relevant to females, a questionnaire was compiled that asked the students what aspects of chemistry they would like to know more about. Included in this list were three groups of topics: those related to health, the environment and beauty, that could be included as examples in the course content but are not normally addressed by chemistry instructors; topics that are frequently used as examples that come from industrial applications of chemistry and, thirdly, topics that form the core components of the course. This survey produced similar information to that obtained by the researchers in the GIST proposal. It found that both male and female students are interested in learning more about subjects related to health and the environment. On the other hand, female students are more interested in gemstones and artists' materials and males are more interested in storage batteries and the internal combustion engine; neither males nor females are very interested in the main topics of the course, namely atomic structure, bonding and chemical kinetics. All the topics of interest to female students were included in the course; when the instructor discussed environmental problems, emphasis was placed on the possible ways of solving the problems using advanced chemical technologies as much as on the causes of the problems.

Since the more negative attitudes of girls to the physical and applied sciences correlates with their inferior visual-spatial ability, a series of exercises designed to develop this ability was incorporated into the experiment. The students did both computer-based exercises and worked with actual three-dimensional models of geometrical figures. Two different versions of the Space Relations Subset of the Differential Aptitude Tests were used to determine the visual-spatial abilities of all the students before and after the intervention. The expected difference between male and female students was found in the pretest, with the average for both genders being in the 80th percentile compared to a national average. The results of the posttest, however, were not anticipated; the scores for the female students in both the experimental and control groups improved significantly, while those of the male students remained unchanged. It would appear, then, that the normal laboratory

exercises, which include a great deal of work with molecular models, increase visual-spatial ability.

Using a questionnaire that was developed by the author and validated by a group of students at another cégep, changes in attitudes during the semester were measured. In the pretest the questionnaire showed a difference in attitudes between males and females towards the chemical industry, with the females' attitudes being more negative. The posttest showed that, within the experimental group only, the females' attitudes had become more positive, although they were still not as positive as the males'. Their was no significant change in the attitudes of the control group. As a result of the pilot study, it was decided to continue the experiment but not to include the visual-spatial exercises, since, although the students found them fun and enjoyed using the Macintosh computers, they were time-consuming and the instructors were not enthusiastic about them.

THE STUDY

The study, carried out in the 89-90 school year, involved six instructors: one male and one female instructor were responsible for both an experimental group and a control group; two instructors, one male and one female, taught only an experimental group, and two other male instructors taught only control groups. Any student who was repeating the course or who failed to complete the course was discarded from the sample. The students were not told the precise purpose of the study; they were simply told that we were carrying out experiments that were designed to make the course more interesting to students. The experimental groups consisted of 52 female and 56 male students and the control groups consisted of 38 female and 51 male students. The interventions used were similar to those used in the pilot study except that audio-visual presentations with accompanying notes were prepared for the instructors so that they would not be obliged to do any extra preparation to teach the experimental groups.

The attitude questionnaire developed in the pilot study was distributed at the beginning and end of the semester to all the students in the experimental

and control groups. Also included in the survey were questions addressing the response of the students to the course content, the visits of the engineers and the profiles in the laboratory manuals. There was also a question on career expectations. All the instructors involved were interviewed at the end of the intervention to assess their attitudes to this type of program.

RESULTS

On the whole the results of the experiemnt were very encoyuraging. The qestionnaire designed to measure attitudes towards chemistry and the chemical industry showed that the attitudes of female students in the experimental groups became more positive during the course of the semester. We attribute the change of attitudes to the interventions. In order to detect any change in interest in the course content due to the interventions, we compared the level of interest claimed by the students in an experimental and a control group taught by the same instructor, since the level of interest in the course was dependant on who was teaching the course. Two instructors taught both an experimental and a control group; in both cases the students in the experimental groups found the course content significantly more interesting than those in the control groups. The provision of role models were viewed as positive by both the male and female students; 80% of the female students and 85% of the male students indicated that they had enjoyed the visits of the chemical engineers. No student commented on the fact that both visitors were women; presumably, women engineers are no longer considered abnormal. Most students admitted that they had not read the profiles of the women chemists printed in the laboratory manuals. Several female students in the experimental groups, but only one in the control groups, changed their minds and were no longer rejecting a career in engineering or the physical sciences.

The instructors all reported finding the experiment a positive experience. One male teacher commented that bringing engineers into the classroom was like "a breath of fresh air" and gave the students a chance to have some contact with the real world. The other male teacher stated that he had never

thought of showing slides in a class, but felt it was a very good idea as it got the students asking questions and started a discussion going, which was rare in his classes. All the instructors stated that they believed it was important that more women entered the physical and applied sciences; however, the males were unwilling to acknowledge the existence of any systemic discrimination. When asked why few women entered these fields, they focused on the amount of work that was necessary and the unwillingness of the new breed of students, regardless of gender, to devote long hours to doing problems and writing lab reports. This insensitivity to systemic discrimination was most evident when the instructors were asked about their reaction to the massacre at the École Polytechnique; the males saw it as the act of a madman, while the women saw it as an extreme manifestation of the problem.

DISCUSSION

It might then appear from these results that it would be a relatively simply to convince more women to consider a career in the physical or applied sciences, at least in Quebec. Here societal attitudes have changed to the extent that female students are now equally represented and equally successful in Secondary 5 math classes. This is also true in college level science programs. It might appear, therefore, that all we have to do is to make minor modifications to the curriculum in our college science courses and invite some women engineers to be guest speakers in our classrooms. Unfortunately the connection between research and practice is not that rational.

Despite the enthusiasm with which the instructors welcomed the experiment, hey have not consciously incorporated any of the modifications into their teaching in subsequent semesters, despite the fact that they were made aware of the success of the experiment. It is clear that old habits die hard, that teachers are reluctant to make changes in their pedagogy and that the additional chore of arranging for guests is not considered worth the effort. Cégep chemistry instructors, like most other teachers, seem to think that what was appropriate for them when they were students is appropriate for the next generation.

Therefore, my recommendation is that, since college-level instructors in Canada are primarily teachers and are not expected to participate in research, they should be required to take courses in pedagogy as a prerequisite for working in the field and they should also be required to take regular summer courses on the latest developments in educational theory. These should include a course on the psychology of gender differences, one on the classroom techniques preferred by female students and, for science instructors, a course on ways of making the curriculum more female friendly.

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BEYOND BEGINNINGS : AN AUSTRALIAN PERSPECTIVE

Jeanette Learmont and Jennifer Lindley

Ce document résume le travail du Advising Centre for Women de la Swinburne University of Technology (SUT), et nous fournit un «instantané photographique» de l'Australie. En plus de promouvoir la participation des femmes dans les domaines des sciences et du génie, le centre examine les questions de rétention des femmes dans les secteurs non traditionnels. Le scénario actuel est considéré comme une des nombreuses étapes de la transformation des relations entre les femmes et les sciences et la technologie.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

699

BEYOND BEGINNINGS : AN AUSTRALIAN PERSPECTIVE

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ABSTRACT

This paper provides an overview of the operation of the Advising Centre for Women at Swinburne University of Technology (SUT), together with a "snapshot" of the national Australian picture. The Centre, as well as contributing to the increased participation of women within science and engineering, has explored issues of retention of women in non-traditional areas. The current scenario is viewed as one stage of a larger continuum of change in relation to women and science and technology.

INTRODUCTION

In Australia, during the 1980's, there was an emergence of an economic discourse in which women were described metaphorically as an untapped pool of talent and skills; an under-utilized resource with the real potential to aid economic recovery. In addition, the social justice agenda of that period embraced the view that equity in higher education should focus on redressing the imbalance of women in non-traditional areas.

The Advising Centre for Women, established in 1989, fits into this context. The Centre was funded for a three year period via a national grant. Its original brief encompassed the promotion of recruitment and retention strategies and practices for women into the non-traditional areas of engineering, science and business.

From 1989 to 1992 the Centre has been unique within the Australian context because

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque International GASAT 7, Canada, 1993

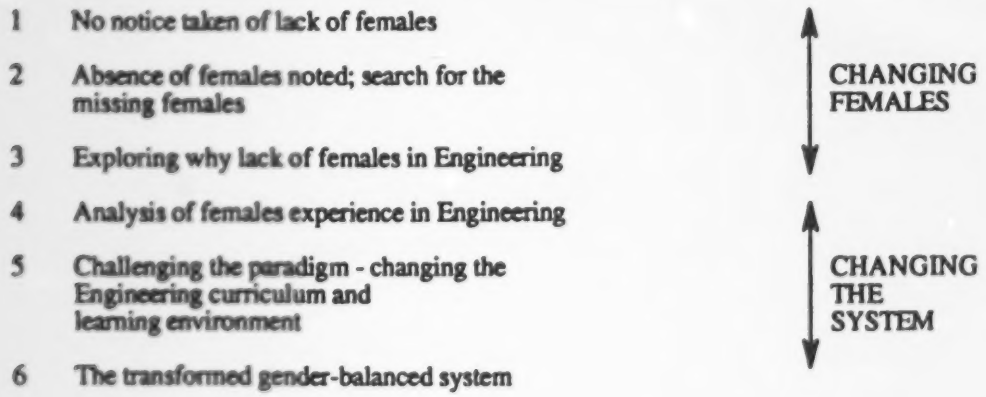
during that period it has:

- focused upon three "non-traditional" disciplines for women, namely Science, Business and Engineering;
- provided a service model combined with the roles typical of other projects, such as resource development, information dissemination, education, media and student support;
- included both mature age women as well as school age females as its target population for recruitment activities;
- adhered to a "non-partisan" approach with regard to referral of clients to a range of post-secondary institutions;

THE CENTRE PLACED WITHIN A MODEL OF THE PROCESS OF CHANGE

The activities of the Centre can be described as comprising one stage in a larger continuum of change. The development of a model based on one devised by Dr Sue Lewis (Lewis, 1991), reveals that much of the work to date has been premised on the notion of changing women to fit a culture which is constructed and gendered "masculine". One can theorise issues of gender and non-traditional study options in terms of a model of change viewed as a continuum of six stages. (See Figure 1)

Figure 1 Recruitment and Retention of Women into Engineering as a Process of Change


1 No notice taken of lack of females
2 Absence of females noted; search for the missing females
3 Exploring why lack of females in Engineering
4 Analysis of females experience in Engineering
5 Challenging the paradigm - changing the Engineering curriculum and learning environment
6 The transformed gender-balanced system
CHANGING FEMALES
CHANGING THE SYSTEM

The original aims of the Swinburne Advising Centre for Women placed it within Stage 3 of this continuum. Within this stage, enormous energy was devoted to the dissemination of information, the development of resources and the wider "education" of young women, careers advisers and their parents. A range of strategies were initiated in order to meet the aims of increased recruitment and retention of women in non traditional areas and included:

RECRUITMENT

Promotion:

- Extensive use of print and electronic media from local through to national levels including production of posters and brochures and media interviews.

"Drop-in" Centre:

- Advice to women about their career options has been provided on an individual basis.

Service Provision:

- Provision of female guest speakers and role models in secondary schools as well as on campus at Swinburne.
- Professional female engineers as a role models for currently enrolled female engineering students.
- On-campus activities in science and engineering for female secondary school students.
- Development and implementation of a co-ordinated series of seminars designed to increase awareness of non-traditional careers. The four session program ran at 12 selected secondary schools.
- Active participation in Careers Fairs and Seminars at secondary schools, post-secondary colleges and venues for unemployed women.

Development of Resources:

- Acquisition of materials to establish a resource base in the shop-front for service provision to members of the community.

- Production of profiles of Swinburne students and graduates of the target disciplines, co-authoring and production of a resource guide *Women in Engineering : Careering Ahead*, creation of course guides and leaflets to assist women graduates moving into male dominated workplaces.

RETENTION

Intervention Strategies:

- *Indirect:* Promotion of networking via pre-orientation days, informal luncheons, focused career gatherings together with the establishment of a "student owned" network and network newsletter
- *Direct intervention:* Industry visits, workshops in "technical skills" and job-seeking skills, forums to address equal opportunity and affirmative action issues, individual follow up of those female students attaining poor results.

Staff Development:

- Provision of workshops for academic staff focusing on "Gender Inclusive Curriculum" (terminology familiar within the secondary sector, but little discussed at the tertiary level) and staff seminars with guest speakers examining issues which impact on women in male-dominated areas of work and study.

IMPACT OF THE CENTRE

Enrolment of Females into Non-Traditional Courses

It is apparent that Australian women's participation in non-traditional areas has increased slowly over the past decade, and Swinburne is no exception as indicated by data on enrolments in engineering (see Table 1).

Table 1: FEMALE ENGINEERING ENROLMENTS IN HIGHER EDUCATION IN AUSTRALIA

Year	National*	Swinburne#
1985	5.2%	3.2%
1989	8.9%	7.3%

(Dept of Employment Education &Training 1990 - most recent available data.)*
(# "A Study of Women Students in Applied Science and Engineering Courses at Swinburne Institute of Technology", Harney et al 1986.)

A closer look at Swinburne, reveals that across the three areas in which the Centre has been involved, enrolments have increased during the Centre's operation (see Table 2). One cannot ascribe a direct causal link, but can only imply that the Centre has, in fact, contributed to this increase. Anecdotal evidence from enrolled students supports this inference.

Table 2: FEMALE FULL-TIME UNDERGRADUATE ENROLMENTS (%) at SWINBURNE

YEAR	APPLIED SCIENCE	BUSINESS	ENGINEERING
1990	33.9	43.5	8.3
1992	35.8	46.5	12.2

(Source: Information and Planning Services, Swinburne University of Technology)

"Drop-in" Centre

Interestingly, an overview of the women seeking careers advice reveals that most have been mature age women whose interest lies in business courses (see Table 3). Analysis of client data to the end of 1992 according to their interests within each age group, shows that the school age group was the most interested in engineering (22%). Business courses were the most popular area of all, and from amongst the three age groups, the tertiary students (67%) expressed the most interest.

Table 3: CLIENTS BY AGE AND AREA OF INTEREST(%)

	SCIENCE	BUSINESS	ENGINEERING	UNCERTAIN	TOTAL
Mature age	19.6	40.5	4.8	4.1	69.0
School age	5.4	7.7	3.6		16.7
Tertiary students	3.0	9.5	1.8		14.3
Total	28.0	57.7	10.2	4.1	100.0

Retention of Females in Non-Traditional Courses

Unfortunately, it is not possible to provide data on the impact of the Centre. The University, in line with most Australian universities, does not yet have a system that readily allows access to such data. Together with other Women in Engineering Projects in Victoria the availability of retention data is being vigorously pursued.

A NATIONAL SNAPSHOT - WOMEN IN ENGINEERING PROGRAMS

In August 1992 a survey was forwarded to those campuses throughout Australia which offered undergraduate engineering degrees. Thirty-four survey forms were issued, and twenty responses were returned. The preliminary findings can be described according to the project aims, target groups and structure.

Aims:

The stated aims of the various Australian projects are remarkably similar, and, in general, can be summarized according to two fundamental criteria:

- To increase the participation rate of women in engineering
- To encourage retention of women within engineering.

While some projects have a broad focus on "non-traditional" areas, most have a specific focus on engineering.

Target Groups:

In most cases, target groups are both senior secondary female students as well as those women already enrolled in engineering studies.

Structure of Projects:

The Australian scenario shows existing Women in Engineering Projects to be varied in terms of formality and structure. While several engineering faculties do have formalized projects with contract staff employed, others rely on the motivation of the Dean, individual academics, the equal opportunity officer or a careers officer. The majority of projects are located within an engineering faculty and are answerable to that faculty. Few projects are externally funded - most rely on internal university funds for their ongoing operation.

Three key issues emerged from the survey:

1 The Question of Retention: Why No Quantitative Data?

While the majority of respondents felt the existence of a Women in Engineering Project had played a positive role in the increased participation of women in engineering, many were quick to note that this was not readily quantified. What is

more striking amongst the responses, however, is the lsck of work conducted in the area of retention. This is particularly noteworthy given the number of campuses which list retention as a central aim of their program.

2 *Why are Male Students Hostile to Women in Engineering Programs?*

A second key issue is that of the hostility directed by male students (though not female students) towards Women in Engineering Programs. This is particularly marked given the generally high level of institutional support noted by respondents.

3 *From Networking to Curriculum Change - Is This the Real Challenge?*

Many of the Women in Engineering Projects indicated that a shift is taking place in relation to their priorities for further work on campus. While networking activities continue to be seen as valuable, when asked about future directions, many of the respondents indicated that staff development was 'on the agenda'.

A transition in programs from a recruitment focus to a consideration of the experience of female students in engineering and, consequently, to issues of teaching practice, learning styles and curriculum, is gathering momentum - albeit in an *ad hoc* and fragmented way.

WHERE TO NOW?

Australian Government funding for the Advising Centre for Women finished during 1992. As the result of an SUT review, the Centre is changing direction and scope. It has evolved into The National Centre for Women: ***Employment, Education and Training.*** This Centre now aims to establish its activities within stages 4 and 5 of the model of change, with a focus on strategic initiatives which challenge the educational system to address teaching and learning issues within such courses. Recruitment activities will no longer be a major focus of the National Centre. Our most daunting challenge is to become self-funding at the end of three

years as SUT has provided funding for two staff only until the end of 1995.

The national survey has provided the National Centre with valuable impetus in terms of future directions. We suggest that gender and science and technology projects have an important role to play in determining the extent and nature of the 'critical effect' which increased participation of women in non-traditional areas might play within Australian higher education.

Specifically, we will adopt some of the strategies that need to be addressed by projects with a mission involving gender and science and technology in higher education in Australia. They include:

- The collection of retention data based on gender should be encouraged as a matter of urgency. Where necessary, staff must negotiate relevant changes to student administration procedures, ensuring they or other female representatives are present at exit interviews.
- Inclusion of male students as an integral part of any strategy development which focuses on the gender reform of male dominated courses. It is vital that attention be devoted to implementing awareness raising strategies and/or programs via initiatives such as targeted workshops, incorporation of gender issues into communication skills units/generalist units and importantly public expressions of support for women in engineering initiatives by academic staff who can serve as powerful role models to male students. The issue of male hostility is particularly urgent given its possible connection to the larger and more complex issue of the gender harassment of women in non-traditional areas.
- Integration of recruitment and retention activities with research and curriculum changes. This is essential if projects and centres such as the National Centre for Women are not to be seen as operating from a marginilised position. Of course, to introduce change within a conservative University environment is to evoke deep-rooted fears, often manifested through avoidance, denial and resistance.

There will be critics who believe that a changing student population does not warrant or require significant pedagogical change. They may attempt to trivialize issues of gender, race and class, and undermine the "authority" of women in engineering staff to comment/intervene in classroom issues. At stake are questions of authority and ownership - over students, over knowledge and over marginilised equity workers. Such questions are imbued with the discourse of power - personal, departmental, professional and institutional (Aiken et al, 1987).

In many ways, we ourselves are in the same situation as the women we have urged to enter non-traditional areas - located within an academic system which can prove hostile to those on the periphery. We have encouraged female students to network, to provide each other with mutual support. Now, from a national and international perspective, let us do the same.

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INCLUDING GENDER IN HIGHER EDUCATION SCIENCE AND ENGINEERING COURSES

Sue V. Lewis

Le sexe est à la base du projet intitulé Swinburne Engineering Education Development (SEED), lancé vers la fin de 1991 à l'University of Technology de Swinburne. Ce projet tentait de modifier le contenu et les approches traditionnelles à l'enseignement du génie au premier cycle. Dans le cadre du GASAT, nous devons tirer parti de l'expérience acquise dans les programmes qui concernent les femmes (par ex., les études, les cours ou les programmes visant à accroître la participation des femmes dans les cours non traditionnels), ainsi que dans les programmes qui remettent en question le contenu du programme d'études traditionnel. Ce document décrit les dilemmes ainsi que les stratégies visant à éliminer les partis pris contre l'autre sexe dans un projet de développement de l'enseignement ordinaire au sein d'une faculté de génie fortement dominée par les hommes.

L'historique de la réforme des sexes dans l'enseignement en Australie a essentiellement laissé de nombreuses facultés de sciences et de génie sans changement, en dépit des excellentes femmes et excellents programmes de génie de nombreuses universités australiennes au cours des dix dernières années. Le mouvement pour la défense des femmes et de l'enseignement sans distinction des sexes n'a pas contribué à apporter des changements aux programmes traditionnellement dominés par les hommes. D'autre part, très peu de programmes ont été mis sur pied dans les établissements postsecondaires et très peu de sources de financement ont été disponibles pour le faire. Le problème de l'exclusion des cadres féminins dans les cours ordinaires demeure sans solution.

Dans le cadre du projet SEED, on a non seulement dû faire face à une certaine résistance à l'égard des défis féminins, mais aussi à une certaine résistance à l'égard de la réflexion sur les pratiques d'enseignement. Ainsi, la nature même de développement éducationnel du projet a été considérée comme une menace. La collaboration était minime au sein de la faculté et encore plus en ce qui concernait la prise de décisions et le travail d'équipe.

Ce document aborde certaines stratégies du projet SEED qui ont commencé à rendre cette faculté plus équitable pour les femmes - il va sans dire qu'il reste encore beaucoup à faire. J'écris dans l'espoir que certaines de ces stratégies seront utiles à d'autres participantes et participants du GASAT pour surmonter la résistance à l'égard des initiatives entreprises et assurer la réussite des projets futurs.

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INCLUDING GENDER IN HIGHER EDUCATION SCIENCE AND ENGINEERING COURSES

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ABSTRACT

The history of gender reform of higher education in Australia has essentially left many science and engineering faculties unchanged, despite the excellent "women and science and engineering programs" in many Australian universities over the past ten years. The gender and education movement has not developed a theoretical underpinning for reviewing and changing the conventional curriculum in courses with male dominated staff or student numbers; there have been very few pilot or developmental projects within post secondary institutions that have advanced our knowledge or experience. Sources of funding for gender and education projects in the higher education sector have also been limited or non existent. The exclusion of feminist frameworks from mainstream engineering and science courses continues to be an issue in Australia that is not being addressed.

This paper outlines the issues encountered and experience of working in male dominated science and engineering faculties as well as the Swinburne Engineering Education Development project where gender was one of the funding guidelines. This project is focussed on developing the traditional curriculum and teaching approaches in the undergraduate engineering program.

As a GASAT community, we need to draw on the experience of programs that target women (eg women's studies courses or recruitment and retention programs to increase the participation of women in non traditional courses) as well as those that challenge the traditional curriculum and teaching in these targeted male dominated courses. Focussing on changing science and engineering rather than changing women and girls! This paper describes issues for young women in some male dominated courses in Australia, patterns of staff resistance to change, as well as strategies for including gender in higher education science and engineering programs.

Introduction:

This paper draws on my experience of working in a number of undergraduate programs in tertiary science and engineering education in Victoria, Australia. One of the dilemmas of writing papers on gender in higher education is the possible identification of faculties and personnel during the development and implementation of educational programs. Faculties and institutions are understandably anxious about attracting a negative "sexist" image through the very existence of a gender reform program, when in reality they are more educationally responsible in recognising the issues and acting, rather than faculties and institutions that deny the validity of

gender reform and may have the same or worse problems. Writing here for the GASAT community also enables me to express the gender issues more explicitly compared with writing an internal science or engineering faculty document.

Over the past ten years, as a GASAT community, we have evolved from the theoretical perspective of changing women to fit into male dominated courses (often referred to as the female deficit approach) with little questioning of the curriculum and teaching within these, through to challenging these courses to reflect both gender perspectives in the curriculum and teaching. This latter approach carries a very different political and educational debate. It is more openly critical of traditional practices in post secondary education and requires enlightened funding that embodies reflection and questioning of established educational practices in higher education.

Higher Education

Gender and science and technology education in the tertiary sector was discussed extensively at GASAT 6: in Australia, tertiary education in science and engineering has continued in the 1970's and 1980's without the gender reforms that have started to occur in the primary and secondary sectors during this time. In primary and secondary education, women have been the gender justice workers for reform. Gender reformers in higher education have been female too but usually with one significant difference: the intervention program workers have not been faculty teaching staff members but women employed to work in programs outside the departments or in centres for women's access to education.

In addition, the theoretical knowledge of a discipline has often been the central criterion for appointment in the higher education sector, without consideration of teaching and educational knowledge. Unlike the secondary sector, the pressures on the tertiary sector to be educationally accountable are very recent in Australia. Now there are expectations of performance appraisal and consideration of teaching as a criterion for appointment and promotion, as well as federal funds for educational development in departments and faculties. The knowledge of gender and education research and theory has been confined to education faculties and has rarely been applied within a science or engineering faculty for examining curriculum, teaching and assessment practices faculty wide. Much of the learning in the primary and secondary sectors about educational change and the importance of gender in educational improvement have not been applied in post secondary education.

Tertiary education also has a culture where autonomy and individuality amongst academics have worked against establishing a collaborative culture to investigate gender issues. It has been much safer to establish women's access units, separated in time and space from the faculties and departments that they are advocates for. Understandably, there is considerable resistance to gender reform within faculties as the very nature of academic autonomy and merit, staff selection and promotion, and indeed the gendered nature of the construction of knowledge itself are soon on the 'gender agenda' as well as the curriculum, teaching and assessment issues.

Unlike the secondary and primary sectors, the basic research and analyses of issues such as classroom and laboratory dynamics, gender biases in curriculum and assessment, sexual harassment procedures and policies, are not established in the literature as the foundation for action based projects to draw on. It is surprising how little gender research has been done in the post secondary teaching environments, beyond the statistical analyses concerning the under-participation of women in science and engineering. Whilst there is very little research information about the lecture and practical class environment for women in male dominated courses, there is considerable anecdotal and current research that is indicating that female students are exposed to the same biases in post secondary education as they have been in the other education sectors and indeed in society in general (Mares 1990 , Hegarty- Hazel 1991,Thomas 1990). There are disturbing reports from England (The Times Higher Education Supplement 3/8/1990), that undergraduate women may be the victims of bias in the assessment process: at one university more first class honours were awarded to men than women until the marking system was switched to anonymous numbers when the gender pattern reversed with more female gaining first class honours. There is clearly the need for further research and analysis of teaching and assessment data.

New issues have also arisen in male dominated courses since the feminist era; sexist harassment of female students (and many male ethnic students) appears to be worse in the 1990's compared with the 1970's and 1980's. Many staff have observed that prior to the 1970's the small minority of female students were treated as a separate species but with almost Victorian era politeness, compared with the blatantly sexist behaviour that some male students now exhibit towards them. Data on how many female students "drop out" of male dominated courses, when and why they do so has been shamefully ignored as a research question and source of valuable information in the tertiary sector. Despite the age of computers and the supposed ease of data collection and retrieval, there is many a bulging file of bureaucratic letters, and no hard data, for

anyone foolish enough to ask for these "drop out" data from science or engineering faculty records.

What are the issues for female students in male dominated courses?

Overseas research has described these male dominated environments as "uncomfortable" or "chilly" (Hall and Sandler 1982, Carter and Kirkup 1990) - it is not the experience of all female students in these courses but is the experience of many young women. In my own interview research with young women (and men) in science and engineering courses in Melbourne, the following issues were commonly identified.

- **The construction of the curriculum around the background formal and informal experiences and interests of male students:**

"I did not do anything to do with electronics when I was younger or at school - meanwhile guys build circuits at home while I think "what's a soldering iron?"

"One day in instrumentation we were presented with a circuit board in front of us and we were expected to know how to start with the practical instructions - you have to understand what the board is about before you can start to do the prac"

"Staff need to be aware that not all students come into the course with the same background"

In one series of interviews with female and male engineering students, 80% of the male students had experience of mechanical tinkering with cars or tractors, electrical hobbies, or building experience outside their formal school experience: none of the few female students had any comparable experience either outside or within their schooling. The background experience of the male student is still regarded as the norm for the starting point of the curriculum. There is resistance by many staff to validate the educational significance of these background differences between many female and male students. Some staff even express irritation that young women expect to study in these courses without experience of mechanical or electrical tinkering, despite these criteria not being mentioned in the course selection material.

- **The nature of student /student interactions:**

"I have to put up with comments such as "I thought you would have failed and left by now" or "you can't do this because you're a girl"

"When you get the males alone they are often very nice and so different from the crowd - but when you get them together in a group they are a 'bunch of dirtbags'"

"If we ask questions in class, they roll their eyes and trivialise our questions - so you feel stupid and stop asking questions"

"Guys support each other and swap their pracs around, and then divide up tasks and cut down on their overall work load. They talk about going to each others places and I sit there thinking 'who are my friends?' You feel really left out"

The severity and frequency of these comments vary from course to course, but are alarmingly common where young women are less than 10-20% of the student cohort. Superimposed on this pattern is the occurrence of "good years" and "bad years" within courses. Some years are comfortable places for most of the female students and other years are distinctly uncomfortable for many of the female students. Apparently a male, macho, sexist culture builds up in some years of a male dominated course and a supportive, friendly culture establishes in other years. Some report that this experience diminishes their enjoyment as well as their learning within the course and in some cases prevents them asking any questions in classes. The most serious and severe treatment is the sexual harassment that many female students report from male students. This issue has still not been addressed comprehensively at any staff development level within these male dominated courses in Australia. Institutional policies and procedures for sexual harassment do exist but are weighed down by bureaucracy and only relate to serious incidences that female students have to pursue through a lengthy drawn out complaint process. Many female students express frustration at the repeated and common "sexist harassment" that permeates their student days. They are angry that nothing is done by staff or the institution to address this environment.

- **The nature and quality of teacher / student classroom interactions:**

"If you ask questions in class guys ridicule you so you stop asking questions"

"Many of the staff are computer heads - they talk 'man to man' as if the female students were not there"

""You should know that " is very offensive on the receiving end"

"I would feel more comfortable asking female lecturers - IF there were more!"

These comments are common for young women to make and they relate to the unthinking and in many ways unskilled teaching within many of these male dominated classes. Students are at pains to clarify that not all staff behave in these ways - but most still do. Male students put down female students in front of the class and their behaviour is unchecked by staff. Blatant examples of sexist overheads and jokes are less frequently referred to but still occur. Staff can target and alienate the young women in their classes with putdown remarks, such as expressing frustration that they are not familiar with "the insides of the combustion engine".

In my discussions with young women in these courses today there are two broad categories of analysis that they bring to their situation. One group is very reluctant to recognise any gender specific issues or discrimination relating to their course experience and the other group is very disgruntled and angry at their treatment by both staff and other male students. However, in group discussions, the former group often volunteer stories of sexist harassment by other male students and staff as they listen to the latter group of females relating their grievances. This pattern is a familiar one: some women and men are aware of gender discrimination in our society whereas others are unaware of these patterns. There is anecdotal and case study evidence, and little statistical evidence yet, that the group of females who walk out of the courses they find alien are the group who are angry and feeling uncomfortable in their chosen course. These young women include many who have "graduated" from the many school based programs encouraging them to pursue science and engineering training and careers. These young women are very capable and represent a loss to both the course and their future profession. There are many unanswered questions about these patterns in male dominated courses that are concerning and in need of research and action.

Patterns of resistance to gender and educational development

These issues present their own case for increasing our efforts to reform higher education courses and learning environments so that they are more comfortable places for female students to pursue their chosen training and career. Within post secondary institutions, there is not only resistance to feminist challenges but resistance to reflection on established curriculum and teaching practices. Even the educational development nature of projects can be perceived as a threat. There is often very little experience of working collaboratively within faculties and an even more limited experience of responsibility for group decisions and processes. Accepted teaching and assessment modes are more limited and cover a very narrow range of teaching styles and consequently learning styles for students.

I think it is important to document the forms of resistance and the frustrations of working in educational development programs with gender reform as a major parameter. To act as "change facilitator" in the face of this resistance in an academic environment can be very taxing. It is hard to find a forum for the exploration of these ideas where it will not be misunderstood and I include here some of the familiar patterns that I have experienced or seen operating over a number of years. They relate to staff interactions in male dominated departments and faculties.

• *"There is nothing wrong with our course - we have been producing successful graduates for years and industry has been happy".*

There are versions 1 to 100 of this statement. This always reminds me of the old adage that - "we haven't got an EO problem because we have no women here". Essentially this approach defends the status quo and indirectly assigns the absence of women from these courses to factors external to the faculty.

• *"The students are not motivated nor capable enough" - or the student deficit model!*

Every issue or perceived problem is defined by some staff as attributable to the low tertiary entrance scores of students, students diminished skills compared with years ago, the new secondary year 12 program, even female students in the minds of some of the staff! In short, this approach can be summarised as the "student deficit model". Whatever problems appear in the undergraduate program are the fault of the students.

• *"We will only consider this change because we have really been doing this all along" .*

When educational changes are planned and submitted through collaborative and decision making processes, discussions can inevitably centre on the perception that "the change is already in place". A suggestion of a collaborative panel to educationally plan and coordinate year level subjects for instance will be seen as already established if staff meet once yearly to coordinate examination results.

•*"I have decided what you should really be doing in this program and the fact that you are not doing it means that you are all incompetent"*

There are many versions of this approach. There can be many versions of what the gender program should really have been doing that would be "more useful" to the Faculty. Sometimes this can be expressed as "you should have been researching the correlation between the entrance scores of the students upon entry and their success or otherwise within the undergraduate program " .... or ... "If we need anything it is lecture kits of overheads, video vignettes and packages we can take out of the filing cabinet for a lecture!".....

• *"That committee can't make that decision as it is my academic responsibility"*

There is a strong sense of preserving existing power relations and hierarchies in competitive academic environments. Any perceived threat to "the way things have always been done here" can be resisted in a variety of ways from blatant rejection on the grounds that it challenges their authority (without any discussion of the educational merits of the suggestion at hand) through to refusal to read or participate in consultative discussions.

• *"What exactly do you mean by this?"*

Nitpicking. Any project document can be read as an opportunity to show up inadequacies. The spirit, overview, intent of the papers or newsletters are ignored and the individual phrases and words searched for inconsistencies, ambiguities, complexity, simplicity according to the reader. The other allied tendency that I have observed is the inability by some staff to read "draft", "the following models were suggested", "consultation" and hence they interpret any written word as already fixed in concrete and decided upon unilaterally without consultation! • • *"I think that you should all do....."*

The use of "I" and "we" and "you" within an educational development team can reveal the extent of identification or separation from the group process. There are often very few skills of group planning, collaborative research or data collection, decision making, educational problem solving or open discussion of educational dilemmas amongst many tertiary academics in science and engineering.

• *"If you don't like my idea, then I will do it anyway"*

Alternatively this translates into "If I am not happy I will pack up my toys and take them somewhere else". There can be little sense of an idea being enriched by the experience and thinking of others. Instead it can become an idea to defend in its entirety.

Developing strategies

This paper ends with some strategies from the experience of myself and others in gender projects and initiatives - needless to say, there is a long way to go. The following table identifies three levels of action; the faculty/institution level, the staff/team level and the support or educational development resources level (inside or outside the institution). As a GASAT community, we can all contribute to the development of strategies to overcome resistance to projects and ensure the maximum success of future projects.

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Strategies for working on gender reform projects in Higher Education...

Faculty/Institution	Staff/Team	Support/Ed Dev
Initiative with explicit support and place in the hierarchy	Build "gender" networks, teams within sections of institutions	Financial resources that support the initiative
Link the program to the policy framework of the institution / initiate new policy directions	Importance of creating a team environment where "women's ways of knowing /working" are legitimised. Make connections to class and culture contexts eg technical/ administrative / unions etc	Enlist the support/involvement of sympathetic males if they are not initially participating
	Reform/ transformation aims of the initiative should be actively discussed, articulated and documented from the start / develop your expertise together	Enlist the assistance of educational development units/ critical friends/ outside expertise or experience/ reference group
	Aim to extend the meaning of the reform eg. not only how to include women in the curriculum but how to restructure the curriculum	
Recognition by the hierarchy of the risks associated with acting in a gender reform role	Recognition / support for the stresses and alienation that can exist for those identified with gender reform	Link to outside projects / personnel/educational development support that may assist to gain perspective on stress
Document	Document	Document

TOWARDS BALANCED GENDER PARTNERSHIP IN TECHNICAL EDUCATION

Paul M. Nyambala

Le projet Women In Technical Education (WITED) a été mis en oeuvre par la Commonwealth Association of Polytechnics in Africa (CAPA) (Association des instituts polytechniques africains du Commonwealth) vers la fin de 1988 en tant que projet régional de promotion de l'intégration des femmes dans les études techniques, la formation professionnelle et les professions connexes. Ce projet est un modèle d'une initiative du tiers-monde visant à promouvoir un partenariat équilibré entre les sexes dans un domaine essentiel au développement intégré. Le projet est mis en oeuvre dans des régions de l'Afrique anglophone couvrant seize pays. Il est conçu pour les étudiantes et étudiants du niveau postsecondaire dans les établissements techniques, appelés instituts polytechniques. Il est à noter que ce projet a également le potentiel d'atteindre plus de cent trente établissements de la sorte.

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719

TOWARDS BALANCED GENDER PARTNERSHIP IN TECHNICAL EDUCATION

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ABSTRACT

The Women in Technical Education (WITED) Project was launched by the Commonwealth Association of Polytechnics in Africa (CAPA) in late 1988 as a regional project for promoting the integration of women into Technical Education, Vocational Training and related careers. It is a case model of a third world initiative to advocate for balanced gender partnership in an area crucial to sustainable development. The project is being implemented in the English Speaking Africa region covering sixteen countries. It is a project targeted at post-secondary level of technical institutions called the Polytechnics and has the potential of reaching over one hundred and thirty such institutions.

INTRODUCTION

1.1 The low rate of participation of women in development generally has been as issue of global concern for sometime now. Despite the various efforts of governments and development agencies - notably the high profile activities of the International Women's Decade (1974 - 1985) - the proportion of women directly involved in the various development sectors remain relatively low. The situation is the more pathetic in the non-traditional areas of technology and industrial development. In the third world generally, and in Africa in particular, the situation calls for sustained effort to cause change. It is in this context that the Commonwealth Association of Polytechnics in Africa (CAPA), came up with a regional interventionist project called, Women in Technical Education (WITED), to attempt to enhance the rate of participation of women in technical education.

1.2 Several authoritative publications have decried the low rate of participation of women in development activities and highlighted the need to integrate women in all development programmes. (Reference Nos. 1-6). Through the WITED project, CAPA was, thus, partly responding to an issue of global concern and partly seeking to fulfil her own internal mandate.

1.3 CAPA was founded in Nairobi, Kenya in December 1978, at the initiative of the Commonwealth Secretariat, London following a recommendation of the 7th Commonwealth Education Ministers Conference which took place in Accra, Ghana in March 1977. The aims and objectives of CAPA centre on the improvement of technical training and the development and transfer of technology especially in the 16 Commonwealth African countries.

2. THE WITED PILOT PHASE

2.1 To fulfil her mandate, CAPA organized a series of training workshops in the period of nearly one decade (1980-1987) for the polytechnic staff in diverse areas of their work. The selection to such courses was random. In order to respond to the new policy initiatives of integrating women in development programmes, CAPA decided to conduct a review of participation statistics for the workshops, by gender, as a basis for formulating new selection criteria.

2.2 A disquieting discovery was that the participation of women was very negligible.

The initial reaction was that the low rate of participation of women staff in the workshops was a reflection of their representation in the Polytechnic system. There was a need for an interventionist project.

2.3 The objectives of the pilot project were to:

- measure women's participation in technical education in a sample of CAPA institutions and countries; identify and analyze why their participation is low; examine other programmes or successful on-going projects for enhancing women's participation in technical education, training and management, for collaboration; and propose a major programme of actions to address the situation.

2.4 The project was implemented in several stages:

- A meeting of experts to re-shape CAPA's original project proposals was held in Kenya in October 1988.
- The training of 22 polytechnic staff in research techniques was conducted in February 1989.
- Research and surveys were conducted in nine countries: (The Gambia, Ghana, Nigeria,

- Data analysis and reports were done in July 1989.
- A policy seminar for government policy-makers, donors, executing agencies, and employers, to consider the pilot project's findings, and make recommendations for follow-up activities, was organized in Kenya in September 1990.

2.5 The surveys revealed a very dismal picture for females in the Polytechnic system (ILO/CAP, 1990). The same situation obtains in technical jobs. The three tables below give typical distributions.

Table 1: Distribution of students by gender in selected polytechnics.

	All Programmes		Technical Programmes	
Polytechnic	Total # of Students	% Females	Total # of Students	% Females
Yaba College of Technology, Nigeria	8510	25	3862	12
Kenya Polytechnic, Nairobi, Kenya	3488	24	2627	17
Accra Polytechnic, Ghana	2498	30	1083	1
The Polytechnic, Malawi	1033	14	664	3
Dar-es-Salaam Tech. College, Tanzania	955	7	955	7
Botswana Polytechnic	621	5	621	5
Uganda Polytechnic	566	9	566	9
Technical Training Institute, The Gambia	532	40	265	11
Northern Technical College, Zambia	495	2	495	2

Table 2: Distribution of lecturing staff by gender in selected polytechnics.

Polytechnic	All Programmes		Technical Programmes	
	Total #	% Females	Total #	% Females
Yaba College of Technology, Nigeria	284	19	179	16
Kenya Polytechnic, Nairobi, Kenya	270	22	203	6
Accra Polytechnic, Ghana	103	14	17	0
The Polytechnic, Malawi	117	12	72	1
Dar-es-Salaam Tech. College, Tanzania	119	15	104	11
Botswana Polytechnic	120	3	114	0
Uganda Polytechnic	100	3	100	3
Technical Training Institute, The Gambia	40	5	34	0
Northern Technical College, Zambia	58	2	57	0

Table 3: Distribution of employees by levels and gender in sample technical jobs.

	No. Males	No. Females	% Females
Technical Managers	451	31	6
Technical Supervisors	1033	50	5
Foremen	1390	33	2
Technicians	1599	28	2
Craftsmen	1163	29	2

2.6 Analysis of factors revealed typical situations for Africa:

(a) A poor background of girls in maths and science.
(b) The lack of equipment and specialized teachers.
(c) The females' lack of confidence and lack of interest towards science and technical subjects and jobs.
(d) The lack of effective career; guidance/counselling.
(e) The socio-cultural and attitudinal beliefs and gender stereotyping by parents and society at large.
(f) The failure by employers to recognize or accept female suitability for technical jobs.
(g) The lack of policies on affirmative action.
(h) The lack of supportive facilities by employers.
(i) The lack of supportive facilities in polytechnics.
(j) The lack of financial support or sponsorship.
(k) The limited career prospects for females.

The emergent situation clearly called for intervention, and CAPA was mandated to do so.

3. THE WITED MAIN PHASE

3.1 Several international development agencies have planned and executed a number of

programmes to help women in development. The central characteristic of most of these programmes had been a focus on grassroots women.

In this case, CAPA came up with a unique programme to address the problems of women at a higher level.

3.2 The long term objective of the main WITED Project is to change government policies and legislation, societal attitudes and the attitudes of the females themselves, and that of the employers, so that the participation of women in technical education and related careers would be enhanced (CAPA 1991). Ultimately it is intended to achieve balanced gender partnership in technical education, and development, generally.

In broad terms the specific objectives of the project fall into six parts:

(a) Securing policy support from polytechnic management, governments, employers and other leaders for the project.
(b) Development of learning resources for training of project implementers, coordinators impart skills to females.
(c) Development of a critical mass of the project advocates.
(d) Conduct further research on women's issues in development.
(e) Securing change of attitudes of peoples society towards the role of women in development.

3.4 The project aims at a number of target groups, notably:

- the school girls, and their teachers;
- the female polytechnic students to act as role models; the polytechnic staff and especially the female staff and the heads of institutions who control the policies.
- the employers in relevant industries.

3.5 A number of activities have been implemented:

(a) A core group of twenty heads of CAPA institutions attended a four-week seminar at the ILO Turin Centre in Italy in October 1991. A follow-up training for an expanded group was held in November 1992 in Dar-es-Salaam, Tanzania.
(b) A competent group has produced modules and materials for training women in such areas as: Women's development problems, (gender issues, trends, challenges, and opportunities) management skills, entrepreneurial skills and advocacy and leadership roles.
(c) The results of the surveys conducted during the WITED pilot phase pointed to the need for more detailed research on areas that confront women.
(d) A total of 120 women would train in three areas, namely; management training; the training of the key persons for the implementation of the project.

3.6 There have been other activities initiated, and implemented at national levels and institutional levels such as:

(a) Sensitization and awareness seminars for policy makers and leaders.
(b) Marketing of technical and vocational careers.
(c) Intervention with Polytechnic and institutional authorities, government policy makers

and employers.

(d) Advocacy programmes through media campaigns.

It is emphasized that this list is not exhaustive, and the project planning group in each country identifies the most critical factors to address.

4. FINAL REMARKS

4.1 The main phase of the WITED Project was launched on 01 July 1991 in Arusha, Tanzania, with a planning meeting for the modules writers workshop. The activities outlined in Sec. 3.5 and 3.6 were then initiated and have been on-going ever since, with varied level of success.

4.2 In conclusion it is necessary to draw attention to one or two aspects of the WITED strategies that makes it an interesting case model.

(a) Whereas the project was intended to enhance the status of women, a substantial part of the project activities are not targeted at the women, but at those who are likely to create barriers to women. The sensitization was mainly at those who control policies. It turns out that the majority of such people are men. In other words, a central strategy for changing the status of women is the removal of barriers to their advancement by influencing men. This is action from without.

(b) Another strategy under the project is the use of training as a tool for change. In this case the central target group are the women themselves - causing change from within.

(c) Networks of focal points for enhancing the role of women in technical education and vocational training are being developed as an important strategy.

(d) Yet another central strategy is that, certain groups of people are used over and over again at the various levels of the activities. The groups build up until critical mass is realized.

(e) And finally, experience in Africa had shown that where a female cause is espoused and advocated by women only, the male counterparts tend to dismiss the cause as a show of feminism. An important WITED strategy has been the full involvement of men in designing and implementing the project. Remarkable positive response has been recorded despite initial show of scepticism.

4.3 The immediate concern of the WITED project is the increased access to women in technically-biased careers and professions. But as a matter of fact the realization of such a goal has ultimate implications for overall development. The technician and technologist is the key resource for the industrialization and development process.

So, ultimately, the CAPA WITED project aims at the realization of balanced gender partnership, not only in technical education and related careers, but also development in general.

4.4 The last remark related to support and collaboration.

So far the project has received substantial support from a variety of donors, agencies and institutions. In the forefront have been ILO Geneva; ILO Turin Centre (and Italian Government); UNIFEM, New York; and the Commonwealth Secretariat. Substantial support has also been secured from Commonwealth Foundation; NORAD and CIDA. We are definitely looking for new opportunities for financial assistance and collaboration in other forms. By its very nature, the WITED project has only just started, and a lot more will have to be done before we can record a perceptible change. The project model also avails itself for replication elsewhere. Indeed, we are working with ILO and ILO Turin Centre to replicate slightly modified models of WITED project in Francophone Africa and Latin America.

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SETTING UP A WOMEN AND SCIENCE COURSE: PROCESS AND CONTENT

Joan Scott

La passion de la pédagogie féministe a fait son chemin jusque dans l'université de ma région du monde. Les étudiantes et étudiants en WS2001 apprennent très peu sur les sciences et je ne sais pas grand chose de leurs expériences dans ce domaine. Autrefois, le WS2001 comportait certains éléments de cette approche : journaux, notes d'information, expérience des élèves, etc. À cette époque, j'étais inspirée, notamment par Ann-Louise Brookes, à inclure ces éléments systématiquement.

La panique avant-cours pour dresser la liste idéale des bonnes lectures et établir un calendrier soigneux pour les examens, les exposés, les présentations et les journaux avait disparu et était remplacée par un vide que les étudiantes et étudiants (et moi-même) pourrions remplir, de façon aussi éparse ou étroite que nous le pourrions ou le souhaiterions.

Des discussions en couples et en groupes plus importants remplissaient les heures de cours, les étudiantes et étudiants décrivant et partageant leurs expériences dans le domaine des sciences. Les questions favorites étaient reprises de ce processus, on dressait une liste des sujets pour les lectures. Fort heureusement, les textes commandés il y a longtemps dans ce coin éloigné du pays contenaient d'intéressantes informations. Les discussions nous ont également permis de reconnaître comment et quand les étudiantes et étudiants obtiennent leurs notes.

Les récompenses précoces incluent la production d'un processus intégré où les mots clés des étudiantes et étudiants (et les miens), des lectures, seront à la base des prochains exposés et examens et, nous l'espérons, vidéos. De même, à ma grande surprise, nous avons plongé relativement rapidement dans des questions assez sophistiquées, mais les partis pris, la recherche sur les différences entre les sexes, ses objectifs et conséquences dans le milieu du travail pour les femmes sont également à l'ordre du jour pour la première partie du cours.

Le document de recherche est disponible auprès de l'auteure.

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SETTING UP A WOMEN AND SCIENCE COURSE: PROCESS AND CONTENT

Joan Scott, Memorial University of Newfoundland, Canada

The excitement of Feminist Pedagogy is weaving its way into the fabric of university life in my part of the world. Students in WS2001 have little formal science education and I am ignorant of what their science experiences are and of how they understand them. In previous years, WS2001 had included components of that approach: journals, issue sheets, the experience of students, etc.. This time I felt inspired, notably by Ann-Louise Brookes, to do it systematically.

Gone was the pre-course panic to produce the perfect definitive list of good readings, and a carefully constructed schedule of exams, papers, presentations and journals, and in its place was a risky void, which the students (and I) could furnish, in as cluttered or sparse a style as we could or wished.

Discussion in pairs, and larger groups occupied class periods as students named and shared their experiences of science. Favourite issues were taken from that process, making a list of topics, for readings. Happily, the texts necessarily ordered long ago in this outlying part of the country, offered relevant pieces. Discussion also identified how and when students would earn their marks.

Early rewards include the production of an integrated process where students' key words (and mine), from the readings, will become bases for later papers and examination, and hopefully some videos. Also, to my surprise, we are making a relatively fast plunge into fairly sophisticated issues. We are beginning with the numbers and the barriers, but bias, and sex differences research, its purposes and workplace consequences for women, are also on the agenda for the first part of the course.

STRATEGIES FOR SECURING ACCESS OF GIRLS IN SCIENCE

Dr. Abdulrahman S. Attiyat

Dans ce document, l'auteure suggère les stratégies suivantes pour attirer un plus grand nombre de femmes dans le secteur des sciences :

(1) Étant donné que les stéréotypes sur le rôle des sexes sont des facteurs d'évolution sociale qui affectent le rôle et le statut des femmes dans le domaine des sciences, la présence de modèles à imiter féminins est indispensable au succès des femmes dans les emplois traditionnellement occupés par les hommes; et fera ainsi comprendre aux femmes que leur succès dans le domaine des sciences est possible et légitime.

(2) Étant donné que la culture féminine est caractérisée par les relations sociales et l'empathie, le programme de sciences devrait mettre l'accent sur les aspects sociaux du secteur des sciences.

(3) Le programme de sciences devrait mettre l'accent sur la pertinence des sciences dans la biologie humaine.

(4) Le programme élémentaire devrait inclure des «expériences de bricolage» pour les filles, avec des outils et des objets divers.

(5) Les parents et le personnel enseignant devraient soutenir et encourager les filles qui s'intéressent aux sciences par le biais d'un langage non sexiste dans les salles de classe et à la maison et en évitant tout point de vue pouvant comporter un stéréotype sexuel reflétant l'idée que l'on se fait du domaine des sciences comme étant un domaine «masculin».

(6) Les travailleuses scientifiques devraient raconter leurs expériences scolaires et professionnelles à des filles, de façon à devenir pour elles des modèles à imiter, et pour qu'elles réalisent qu'une femme dans les sciences, c'est un phénomène tout à fait naturel.

(7) Les filles seront intéressées par les sciences uniquement si elles vivent au sein d'une société dans laquelle elles ont autant de pouvoir que les garçons pour décider des priorités, des façons de faire et de l'emploi de la recherche scientifique.

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Strategies for Securing Access of Girls in Science

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ABSTRACT

In this paper, the researcher suggests the following strategies for securing a greater proportion of girls in science:

(1) Since sex-role stereotype is a societal factor that affects the role and status of girls in science, then the presence of female role models is crucial to the success of girls in traditionally male endeavors; and hence make girls feel that success in science is both possible and legitimate.

(2) Since feminine culture is characterized by social relations and empathy, science curriculum should be focused on the societal aspects of science.

(3) Science curriculum should be focused on science's relevance to human biology.

(4) Elementary curriculum should include "tinkering experiences" with tools and objects, for girls.

(5) Parents and teachers should support and encourage girls in science, via the usage of a non-sexist language in classroom and at home, and avoid sex-stereotyped views of science as masculine.

(6) Women scientists should tell girls about their education and career to provide them with role models, so that they will feel that women scientists are something quite natural.

(7) Science will raise girl's interests if they live in a society in which they equally govern with boys the priorities, ways, and use of its scientific research.

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Strategies For Securing Access of Girls in Science

During the past few decades, a considerable amount of research has investigated sex differences in ability and performance in natural sciences. The research documented large gender differences in interests and achievement in science (Cole, 1979). In the USA, for example, the Second International Science Study indicated that boys ranked higher than girls in science at the fifth as well as the ninth school levels (Report on Education Research, 1984).

In most of the world, there are sex differences in the selection of academic tracks (Science vs. nonscience) as well as in the choice of career. For example, in Jordan, only 37% of the students who selected the science track in 1987 were girls. In Norway, Imsan (1987) reported that only 13% of the girls about age 15 would like to enter a scientific track. In contrast, 47% of the boys wanted to select the science track. A recent Finnish study (Peltonen, 1987) indicated that only 25% of the girls in the higher level secondary school plan to choose a male career. The research findings also indicated that girls even today plan to choose their careers so that they can combine working life with the traditional family life.

Indeed, sex differences in high school science and math courses lead to differences in educational opportunities and rewards. According to the data from the University of Jordan Statistical Yearbook (1983), we can observe that while the proportion of men who eventually graduated was only slightly greater than the corresponding proportion of women (55% to 45%), there was much greater sex imbalance in particular disciplines. For example, women constituted only 25% of the students in math, a ratio of 1 to 4. Men were much more likely than women to major in physics and chemistry as well (ratios of about 5 to 1), while women were as likely as men to major in biology.

Likewise, the National Science Foundation (1984) indicated that, in the United States in 1981, although half of undergraduate students were women, women represented only 35% of all science degrees. Similar assessments were found in almost every country in the world. For example, Marangu (1987) reported that, in Kenya, first year women students have increased from 29 in 1977 to 100 in 1986. This increase is impressive, but when we consider the total of first year enrollments in the 1986/1987 academic year, this is only 28%.

In the USA, women received over 40% of bachelor degrees awarded in the biological sciences, psychology, mathematics, and social sciences in the year 1979. In Poland in 1940, girls represented less than 5% of science students. However, in 1981, girls represented 28% of the students in upper secondary science programs, and 30% of the students in the fourth-year college programs (Chivers, 1984).

In England, although women constitute over one-third of all students in higher education, they account for less than one in seven undergraduates in physics and for less than one in six in chemistry (Head, 1979).

Indeed, these are depressing results, given that most countries in the world have legislation against discrimination in the labour market, and compulsory school programs which aim at promoting greater sex equality.

Constraints and Influences that May Affect the Development and Career Decisions of Female Scientists

In addressing the problem of underrepresentation of female in the area of science, it is necessary to discuss the influences and constraints that tmay be acting on the development and career decisions' of potential young women scientists.

Reviews of the relationship between feminism and science have focused on philosophical problems presented by cultural characterizations of nature as feminine and science as masculine.

For the seventeenth century scientists, it was clear that science was characterized by terms in the right column. One could also add men to the right column and women to the left. So it was clear that science is culturally defined as a masculine domain and that women are not suited for science. If today we have to add women to one column and men to the other, we can easily do that. We still bear in our minds the notion that physics is not very suitable for girls, because science is an objective and rational edneavor.

These cultural notions of masculinity and femininity are transmitted to the youth. The transmission is generally very successful, because gender is the most profound aspects of social life and personal identity (Imsen, 1987). Indeed, gender is a fundamental attribute in almost every culture. One must be either male or female. Gender is woven into the social rules that regulate relations between boys, between girls, and between boys and girls. Accordingly, a girl has to behave like a girl and tries to avoid behaving like a boy. To put it differently, from the time a female finds out that she belongs to the female sex, she begins to identify closely with stereotypes associated with females. Over time, girls are socialized to think that they should value things differently from boys and they begin to engage in different types of activities (Imsen, 1987(. Girls become girls by performing activities within the feminine domain such as care activities, whereas boys become boys by entgaging in activities within the shared masculine domain. Accordingly, girls do not become girls by trying to get grips with science, becuase science is defined in masculine terms.

Later on, when young women try to choose possible career paths, they are faced with the fact that many more men are represented in the field of science. Teachers, parents, peers, and to some extent, school-counselors, may all add up to the fact that girls accept female stereotypes and do not consider all the possible alternative careers open to them. Unfortunately, parents and teachers display less confidence in females' math and science abilities, although recent research reported that girls at secondary school often reject physics and chemistry, not because they can't do them, but because they won't do them. And they won't do them because they lack the interest in science. For them, science is too much object-oriented. Moreover, it is almost not possible forthem to form personal opinions in physics; they cannot integrate their personalities in it. It is so unsympathetic to their interests, and so much does its use-especially its military use. Some women think seriously to abandon science and to return to nature not to be separated from it by science it has brought into being (Sayers, 1987).

To the many people, being a woman scientist does not fit into the traditional approaches to motherhood and partnership. This affects the young women's choice of career and career planning. Most of them want to have children. Although they plan to share the routine household duties with their mates, they still think of child care as their only responsibility. Indeed, men, usually are unwilling to spend more time in family life (Wagner, 1987).

This splitting up-of working in an unusual profession and of having to conform to conventional ideas of motherhood-plays an important role in actual conflicts at work. Whenever the profession seems to be threatened, many women shift radically to the traditional female role: They choose to have children. Success at work reinforces the notion of postponing motherhood until the thirties of age (Wagner, 1987). On the other hand, success at work may lead women to some kind of conflict between the role model for a woman and a female scientists. This is revealed by the difficulties in answering questions about women's femininity. Most women scientists report that femininity is something negative and hence, cannot accept any of it in themselves. Some of them report that the only female trait they have is to given birth to children.

This kind of differentiation between males and females, surely limits the access of women be science endeavors.

Some Suggestions for Change:

As indicated before, sex-role stereotyping affects women interested in pursuing educations and careers in science. The stereotype of women as emotional, nurturing, and subjective suggests that women are not suited to science. Moreover, the masculine

stereotype, logical, analytical, pragmatic, and objective, which is commonly used to describe science as masculine, may deter women from entering science, and hence, serves to limit women's potential contribution to science. Sex-role stereotyping, however, is a societal factor affecting both the role and status of women in science. It is anticipated that the presence of female role models is crucial to the success of young women in traditionally male areas and hence, make women feel that success in science is both possible and legitimate.

Strategies for securing a greater proportion of elementary and secondary school girls in science endeavors have to be based on a grasp of feminine culture, a grasp which also trascends merely banal manifestations of that culture like sewing machines and washing machines (Imsen, 1987).

Feminine culture is characterized by empathy, relationship, and wanting to look one's best. Therefore, we have to focus on the social aspect of science; that scientists must cooperate with each other, meet people, and helping them to solve problems. If we try to clearify the uses of science, science will stimulate girls greatly. One way to stress the importance and the usefulness of science is to teach science in the context of a societal problem. This often takes shape as an interdisciplinary project around a theme (e.g., energy problems in developing countries). We can illustrate and explain all kinds of physical, chemiscal, and mathematical issues in the context of such a theme. Another way of encouraging girls' interests in science is to focus on its relevance to human biology. Kelly et al. (1984) suggested that elementary school science follows the lead of television science in order to find different ways of teaching certain subjects. To illustrate, girls who are uninterested in finding out how machines work, they may be introduced to moments and forces by finding out how muscles work. In this way, we can raise the interests and motivation of girls to science. Also, we have to look for the strengths of feminine culture, and build on those. We should not make science a threat to all what is seen as feminine. We must try to make the cultural implications of gender less opporessive for females.

In addition, since boys report more "tinkering experiences" with certain tools and objects such as cars and screwdrivers, and with certain toys such as electrical kits, it is suggested that elementary curriculum should include such "tinkering experiences" for girls. And that both girls and boys should take technical craft studies in order to increase their scores on spatial-visual measures (Kelly et al., 1984).

When planning to choose a career, young women must have knowledge about science. To increase the number of women working in science, the knowledge of this area must be introduced in a proper way at an early age. It could be suggested that science should be taught in kindergarten, in a concrete way, through describing daily life

phenomenon as a part of science and technology. Examples should be taken from the interests of both girls and boys (Peltonen, 1987).

Girls planning a career in science need to be supported. Therefore, teachers should be informed about this fact, and they should be advised how to support the girls. Recent research reported the following characteristics of teachers who succeed in encouraging girls in science: Are supported in their teachings by parents of their students, maintain organized and well-equipped stimulating classromms, use non-sexist language in classroom, use information about science-related career opportunities and the prerequisites for them, try to develop spatial-visual skills through exercises and avoid sex-steroetyped views of science as masculine.

Moreover, it is important that women scientists tell the girls about their education and career to provide them with role models, so that they will feel that women scientists are something quite natural and are not very clever geniuses to whom math is obvious. Hence, it is good for them to meet women scientists and see that they are just like anybody else.

At the secondary school, discussion groups for girls could be formed. These groups could be a place where girls could talk about the difficulties they face and they could get the proper information about working life and studies. Girls should be counselled so that the most capable and motivated students are encouraged to pursue science studies at higher levels. Long-term follow up studies on the progress of girls who recieved help through the counselling program should be attempted.

At the university level, in the USA where equal opportunity programs have had liegislative and legal support, rapid incrrease in numbers of women entering science area occurred between 1972 and 1980. In addition, both the United Kingdom and Sweden have extensive programs to increase the number of women in science. The Swedish program provides for role modeling as well as for course work.

At the professional level, women scientists continue to face threats in their profession. For example, in 1983 more than 60% of mothers in the USA with children under 6 worked outside the home, however, only 40% of all 2-and 4-year US campuses had any kind of child care facility (AAC, 1983). Moreover, today, it is very hard for young women to get a permanent job as the employers are afraid they will bear a child, and stay at home for almost a year. If it should be compulsory for both men and women to share the parental leave and stay at home with their children, then it would be an equal risk for the employers to employ women and men. This would diminish the discrimination of women having academic degree, and in this way help the women

working within the field of science and fostering economic independence as well as maintaining family life (Peltonen, 1987).

Furthermore, inequal pay between men and women scientists persists in most countries of the world. Women scientists earn a fraction of what men scientists earn. A proposed agenda for action, however, should be based on what happened recently in Europe. For example, Swedish women now earn 90% of that of their male conterparts. Indeed, Sweden's supportive family policies have helped more women reach their potential. A more positive vision, however, has come from Arab World where men and women scientists have equal pay.

Finally, science will only raise women's interests, if they live in a fully egalitarian society in which they equally govern with men the priorities, ways, and use of its scientific research. Till now, women have little to say in this matter for they are, indeed, underrepresented in science's higher and more powerful ranks where its future direction is decided. Only when women equally govern with men science and society, will there be any hope of science fulfilling the needs of women a like with those of men (Sayers, 1987).

When we have reached such a state, women could perhaps get a good self-confidence in science. Then it might be possible for women to develop an alternative science.

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ATTRACTION AND RETENTION OF WOMEN IN ENGINEERING - UNDERGRADUATE SURVEY OF ENGINEERING STUDENTS AT THE UNIVERSITY OF OTTAWA AND MANITOBA

Alison Baignée, P.Eng.

Depuis les années 1850, les femmes de l'Amérique du Nord n'ont pas cessé de faire campagne pour le droit d'accès aux professions libérales. Une grande distance aura pourtant été parcourue depuis lors, car à l'heure actuelle, on fait état d'une participation égale, de la part des femmes et des hommes, au sein des professions libérales. Toujours est-il que le domaine des sciences pures et appliquées demeure l'exception à la règle. En génie, les femmes formaient seulement 14 % de d'effectif des classes de premier cycle en 1990 et 4 % de la population des ingénieures et ingénieurs. Pourquoi si peu de femmes choisissent de faire des études de génie dans les universités canadiennes? Les facultés de génie des universités d'Ottawa et du Manitoba ont décidé de trouver réponse à cette question, afin de renverser la tendance.

En juillet 1990, un comité ad hoc de l'Université d'Ottawa est arrivé à la conclusion que, pour avoir du succès, un programme qui cherche à attirer et retenir les femmes dans les études du génie exigerait la participation de toutes les étudiantes et de tous les étudiants et une bonne compréhension de leurs besoins et préoccupations. À cette fin, un sondage a été effectué, en janvier 1991, auprès de toutes les étudiantes et de tous les étudiants de premier cycle. L'Université du Manitoba a effectué ce même sondage en février 1991, en élargissant le questionnaire pour tenir compte des besoins spéciaux de ses propres étudiantes et étudiants. Le questionnaire abordait une vaste gamme de questions, dont les obstacles, les programmes/services, les bourses d'études et l'ambiance générale. Cinquante-cinq pour cent des étudiants et 85 % des étudiantes de l'Université d'Ottawa, et 30 % des étudiants et 40 % des étudiantes de l'Université du Manitoba ont participé à ce sondage.

Ce document est un compte rendu détaillé des résultats de ces sondages, qui met en lumière les tendances et les problèmes toujours présents au sein de nos universités dans les années 1990. On y présente les conclusions de l'auteure et un plan provisoire pour le changement.

ATTRACTION AND RETENTION OF WOMEN IN ENGINEERING - UNDERGRADUATE SURVEY OF ENGINEERING STUDENTS AT THE UNIVERSITIES OF OTTAWA AND MANITOBA

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ABSTRACT

Since the 1850's North American women have campaigned for the right to enter the professions. We have come a long way since then with the majority of professions today enjoying equal participation of men and women. The exception, however, is still pure and applied science. In engineering, women accounted for only 14% of undergraduate enrolment in 1990 and 4% of the engineering profession. Why are so few women choosing to enter engineering at Canadian universities? The faculties of Engineering at both the Universities of Ottawa and Manitoba decided to get some answers in an effort to reverse this trend.

In July 1990 an ad hoc committee at the University of Ottawa agreed that if a program to attract and retain women in engineering was to succeed, it would require the full involvement of the students and a clear understanding of their needs and concerns. To this end a survey of all undergraduate students was conducted in January 1991. The University of Manitoba conducted the survey in February 1991 expanding the questionnaire to take into account the special needs of their students. The questionnaire covered a wide range of issues including barriers, programs/services, scholarships and the overall climate. Fifty-five percent of men and 85% of women students from the University of Ottawa and 30% of men and 40% of women from The University of Manitoba responded to the survey.

This paper reports in detail the results of these surveys and highlights the trends and the problems that still exist in our universities in the 90s. It includes the author's conclusions and gives a blueprint for change.

Background information and methodology

In the Fall of 1990 the Faculty of Engineering at the University of Ottawa had 956 students enroled in undergraduate programs. Of this total, 16% were women, or 157 students. The Faculty offers programs in chemical (33%), civil (21%), computer (10%), electrical (13%) and mechanical engineering (9%). The percentages represent the proportion of women enroled. Five hundred and seventy-four students responded to the survey (60% rate of response), 134 women (85% of their population) and 440 men (55% of their population).

In the Fall of 1990 the Faculty of Engineering at The University of Manitoba had 1,067 students enroled in its undergraduate programs. Of this total, 11% were women, or 118 students. The Faculty offers programs in agricultural (8%), civil (15%), computer (7%), electrical (9%), geological (3%), industrial

(9%) and mechanical engineering (10%). The percentages represent the proportion of women enroled. Three hundred and thirty-four students responded to the survey (31% rate of response), 47 women (40% of their population) and 287 men (30% of their population).

The survey consisted of 23 questions which were discussed with the students in the initial stages. The students were enthusiastic and had many worthwhile comments which made the survey viable, current and successful. It was distributed to all undergraduate students at both universities.

Who or what influenced students to consider engineering as a career

Enjoyment of mathematics and science classes (70%), followed by "parents and other relatives" (28%) had the greatest influence on women students at the University of Ottawa in choosing engineering as a career. They were least influenced by shop classes followed by counselors and teachers. Men students were also most influenced to consider engineering by their enjoyment of mathematics and science classes (56%) followed by enjoyment of "tinkering" or repairing things (28%). They were least influenced by teachers and counselors (Table 1).

TABLE 1
What or who helped you decide to consider engineering as a career? (%)

	University of Ottawa		The University of Manitoba	
	Women	Men	Women	Men
Enjoyed mathematics & science classes	70	56	85	67
Relatives (includes parents)	28	25	36	37
Enjoyed tinkering & repairing things	16	31	28	42
Other	16	16	23	22
Friends	16	12	19	17
Teachers	9	7	26	13
Counselors	7	7	11	11
Enjoyed shop classes	7	11	9	20
Enjoyed creating things	*	*	36	40
Liked dealing with people	*	*	23	16
Enjoyed communicating ideas	*	*	17	10
Enjoyed service to people	*	*	9	10

* Not applicable

The University of Manitoba added four new categories to the list: enjoyed communicating ideas, liked dealing with people, enjoyed creating things and enjoyed service to people. Women students were most influenced by their enjoyment of mathematics and science classes (85%), followed by parents or relatives (36%). They were least influenced by an enjoyment of service to people. Men students were most influenced by their enjoyment of mathematics and science classes (67%), followed by "tinkering" or repairing things (37%). The least number of men considered engineering because they enjoyed com-

municating ideas (note: women were twice as likely to choose this category) or enjoyed service to people (Table 1).

It comes as no surprise that students generally choose engineering because they enjoy mathematics and science. It is also no surprise that neither men nor women are influenced by counselors or teachers. The results also support the fact that men students are often better prepared for the "hands on" engineering. The real surprise comes to light in the fact that so few men or women are attracted to engineering because of an enjoyment of service to people and seem unaware that engineering directly and indirectly benefits humankind. Men and women generally want to work as engineers in the field of their choice for a specific company or organization. They aspire to be managers and supervisors, etc. Only a handful of men or women have aspirations of helping people.

The results suggest several ways to attract and retain students. Practising engineers and engineering students need to go into the grade schools and high schools of their communities and promote engineering as an exciting career which helps people (this may attract an untapped pool of new engineers). Going into the schools as a team of engineers or engineering students, female and male, may help to give students a better perception that engineering is a choice open to everyone.

Practising engineers also need to link up with engineering schools. The survey clearly showed that often the engineering students themselves lacked a clear understanding of what engineers do and what engineering is all about (regardless of year of study).

Barriers to completing a degree in engineering

The University of Ottawa survey presented the students with a list of 10 possible barriers to completing a degree and asked them to check all those that were appropriate (see Table 2). The greatest proportion of women indicated they experienced "no barriers". Following "no barriers" was "difficulty of school work". Their male colleagues indicated a lack of financial support as their greatest barrier followed by "no barriers" and "difficulty of school work".

A disparity arose in the number of students who marked discrimination as a barrier to completing their degree. Women students were nearly three times as likely to indicate this was a barrier compared to men students (ranked fourth in a list of 10 for women versus last for men). Discrimination came from professors, fellow students and teaching assistants. Women students expressed discouragement concerning the inability of some men, be it professors, students or teaching assistants, to take them seriously. Differential treatment was documented in several cases. Discrimination towards men students was generally racial.

TABLE 2
Barriers to completing a degree in engineering (%)

	University of Ottawa		The University of Manitoba	
	Women	Men	Women	Men
There are no barriers	35	32	6	17
Difficulty of school work	29	32	26	22
Lack of financial support	13	37	38	33
Outside responsibilities	13	18	38	28
Discrimination	11	4	*	*
Competition	8	9	13	13
Lack of peer support group	7	7	9	18
Other	7	7	6	13
Isolation	6	5	9	4
Workload too heavy	*	*	64	47
Inequities	*	*	4	5

* Not applicable

The University of Manitoba added two new barriers to the list, 1) workload too heavy and 2) inequities, and removed discrimination. Both women and men students overwhelmingly indicated that "too heavy a workload" was the greatest barrier to completing their degree. Following too heavy a workload was financial difficulty. Outside responsibilities was a close third in ranking, usually these students were working part-time (the survey revealed that over one third of engineering students at The University of Manitoba and the University of Ottawa work part-time). "Inequities" was one of the least often cited barriers.

Students and Faculty members must be sent a strong message that sexist and racist behaviour is unacceptable. The engineer a university sends out into the workforce is a reflection of that institution and this is a serious issue. Sexist and racist attitudes are costly and unproductive. In today's highly competitive global market there is just no time for the problems it creates.

Programs/services aimed at retention

This was an extremely important part of the survey as the programs/sevices listed in the survey questionnaire have been proven to be very successful in retaining women students at several universities across the United States [1,2,3]. Not only have retention rates improved but the confidence level of the students was strengthened. At the University of Minnesota, for example, tutoring and advising/mentoring programs have increased retention of first year students by 27%, and the overall grade average of the students rose [3]. The tutoring program has been immensely rewarding to both the participant and the tutor and has alleviated the demand for instructional assistance from an already overloaded faculty.

The students were asked, "If your faculty were to offer the following programs/services under the direction of your peers or alumni, which would you find useful and which would you be willing to become involved in?" (see Table 3). It should be noted that the University of Ottawa offers tutorials for some first year courses under the direction of Faculty but historically students rarely made use of these programs.

The greatest number of women students indicated that tutoring (53%) would be useful, followed by

TABLE 3
University of Ottawa
If your faculty were to offer the following programs/services under the direction of your peers or alumni, which would you find useful and which would you be willing to become involved in? (%)

	Women		Men	
	Find useful	Willing to become involved	Find useful	Willing to become involved
Tutoring (teaching)	53	25	51	22
Counseling (practical advice)	44	16	35	8
Mentoring (personal experience)	41	26	33	13
Advising (help make choices)	40	14	36	13
Seminars/conferences	36	17	30	10
Support groups (common concerns)	22	16	21	10
None of the above	9	46	20	59
Other	4	1	2	1

counseling (44%). They were most willing to become involved in mentoring 26%), followed by tutoring (25%). The greatest proportion of men students indicated that they would find tutoring useful (51%) followed by advising (36%). The programs/services men and women were most willing to get involved in were tutoring, followed by mentoring and advising.

The ad hoc committee for women in engineering of the University of Ottawa is currently soliciting funds from industry to be used to set up a tutor/mentor program run by the students. The tutors will be on a paid and volunteer basis. We hope this approach will foster a cooperative attitude between men and women students. Volunteers will be rewarded for their community involvement. When funds have been raised, help for financially disadvantaged students will be made available. What was brought to light by the survey was that in some cases, buying books would go a long way in helping a student continue with their studies. Auxiliary programs will be set up to address the special concerns of women students.

The survey questionnaire for The University of Manitoba phrased the question as follows "Which programs or services offered by the Faculty of Engineering would you find useful and which would you be willing to become involved in?" Both men and women students indicated they would find tutoring

most useful followed by seminars/conferences. It is interesting to note that women students were more likely to become involved in the programs/services compared to their male colleagues. However, a sizeable proportion of both were willing to become involved in the programs they chose as useful. When asked what seminars /topics would interest them most there was an overwhelming desire to learn more about what engineers do and opportunities/career possibilities available to them (Table 4).

TABLE 4
The University of Manitoba
Which programs or services offered by the Faculty of Engineering would you find useful and which would you be willing to become involved in? (%)

	Women		Men	
	Find useful	Willing to become involved	Find useful	Willing to become involved
Tutoring	55	32	38	18
Seminars/conferences	40	23	38	16
Advising	38	17	29	12
Counseling	38	17	18	7
Mentoring	26	19	17	8
Support groups	26	21	9	6
None of the above	6	13	18	25
Other	4	2	2	2

Special scholarships for women or particular classes of engineering students

The question of special scholarships for women students (question asked in the University of Ottawa survey) or for particular classes of engineering students (question asked in The University of Manitoba survey) caused a great deal of concern. Many individuals took the time to express their views.

At the University of Ottawa nearly half of the men respondents did not agree with awards solely for women. Colleen Grover in her survey of engineering students at The University of Western Ontario fount the same results [(4)]. The reasons they gave: 1) it is a clear form of segregation, 2) it would further intensify resentment and hostility, 3) it is discriminatory, and 4) it would not be promoting equality. Fifty-one percent of men respondents agreed with special scholarships for women. However, many qualified their answer by stating it would be acceptable only when there are some for men as well, and only when they do not promote a double standard.

Seventy-eight percent of women respondents at the University of Ottawa agreed with special scholarships for women. However, some qualified their answer by stating it would be acceptable only when there are equivalent scholarships for men students and only when they are solely to promote entrance into the field. The remaining 22% disagreed with special scholarships for the following reasons: 1) it would be

reverse discrimination, 2) scholarships should be earned/deserved - not because you are female, and 3) there should be no difference between men and women.

The University of Manitoba modified the question slightly to read "Do you agree with special scholarships for particular classes of engineering students?". Fifty-three percent of men respondents did not agree with special scholarships for any particular class of engineering students, 44% agreed. Sixty-six percent of women students agreed with special scholarships, 32% did not and 2% did not respond.

The Manitoba survey asked those students who agreed with special scholarships for particular classes of engineering students to indicate which groups they felt required this sort of award (classes of students listed included, women, rural, aboriginal, visa and members of social/political groups). The greatest proportion of men who agreed with special scholarships felt they should be for rural students (58%), followed by aboriginal students (46%), and then visa students (31%). Women and social/religious groups ranked last with 29% and 14% of respondents respectively. In contrast, 90% of women who agreed with special scholarships felt they should be for women students, followed by rural students (65%), and then aboriginal students (61%). Visa students and members of social/political groups ranked last with 35% and 13% of respondents respectively.

Manitoba men students agreed with their counterparts at the University of Ottawa who were against special scholarships for women but they also were concerned about special attention to other minorities. The concern expressed by the men at Manitoba was that special treatment of a particular class of student would promote ill feelings and an antagonistic environment.

Men generally agreed the problem of the low numbers of women in engineering was that girls in grade school and high school were not encouraged to continue in the maths and sciences. To offer them money would be a bribe and it would not solve the problem. It would be far better to encourage girls in their early years. The male students did not accept that they were personally responsible for the present injustice and although sympathized with societal problems questioned why they were being singled out to put it right.

It is the author's opinion that if the feelings stated by men engineering students are ignored it has the potential of creating a hostile environment in which to study. It was the feeling of the ad hoc committee for women in engineering at the University of Ottawa that although we will implement proactive programs for women, we need to address the whole student body. The survey did bring to light the fact that often men students do not understand why at this particular time, there is a problem. Again, it is

the author's opinion that the student body needs to be educated that there is a problem and a need for change. One possible way is through workshops, seminars or conferences.

Negative or sexist attitudes displayed by Faculty members and students

The students at the University of Ottawa were asked if they found that there were negative or sexist attitudes displayed by Faculty members.

How did the women at the University of Ottawa respond? Thirty-eight percent of women students found negative and/or sexist attitudes were displayed by faculty. Isolating the response by year of study revealed an interesting trend - first year 15%, second year 35%, third year 50%, and fourth year 58%. The most common negative or sexist attitudes reported were: 1) sexist jokes and remarks, 2) suggestions that women do not belong in engineering, and 3) not being taken seriously. These concerns were expressed not only towards faculty but also teaching assistants. Many of the women respondents qualified their answer with, "only a few professors", "only happens sometimes", or "occasionally".

How did the men students at the University of Ottawa respond? This required the male student to consider the women's perspective. Thirteen percent of men indicated that there were sexist/negative attitudes displayed by faculty and teaching assistants towards women students. This proportion went as high as 23% of respondents in their fourth year of study. Their written comments were analogous to the women's citing sexist jokes and remarks and macho attitudes. In fact the men tended to be more direct than the women. Some men who answered "yes" explained it was "just the usual stuff" and "engineers often believe they are supposed to be sexist".

The University of Manitoba separated the question into two parts: "Do you feel that there are any sexist attitudes displayed by Faculty members?" and "Do you feel that there are any sexist attitudes displayed by engineering students?". Forty percent of women indicated that there were sexist attitudes displayed by Faculty members and fifty percent indicated there were sexist attitudes displayed by engineering students. The attitudes were analogous to their colleagues at the University of Ottawa. Thirty-three percent of men respondents agreed that there were sexist attitudes displayed by Faculty members, however, a few indicated it was against men. Forty-two percent of men respondents felt that there were sexist attitudes displayed by engineering students.

Faculties of engineering should issue a policy statement that differential treatment of faculty, students or support staff is not appropriate and will not be tolerated. Faculty members and students need to be educated on climate issues. This could be accomplished through workshops, seminars or conferences.

Issues concerning male/female interaction

The University of Ottawa survey asked the students what other issues concerning male/female interaction they felt needed to be addressed. The issues of concern that both men and women respondents felt needed to be addressed were: professionalism, humanitarianism, and equality. The men and some of the women who took the time to write their concerns felt that equality should be promoted but with no special favours. Both genders agreed that more women students and professors were needed but again it should not be promoted by monetary methods. A number of men students expressed their puzzlement with this question. Why were women being treated differently? Why were they being given special awards? They genuinely did not admit to a problem nor did they understand what is was. *This suggests that programs that eliminate misunderstandings and misconceptions among students are desperately needed. It is our hope at the University of Ottawa that the tutor/mentor program can be used as a vehicle for this. Workshops, conferences, or seminars are other avenues. It is the author's opinion that professionalism, humanitarianism and equality should and could be part of the engineering curriculum.*

Concluding remarks

Although the programs/services listed in the report in which students expressed interest are in the developmental stages many of the suggested activities have been established and are ongoing. For example, students at both universities are particularly active in going into grade schools to talk to students and teachers. The surveys have proven to be an indispensable tool in the development of new programs and courses of action to encourage more female participation in science and engineering. In addressing the problems of women engineering students it has been found that we are also solving problems that already exist for men.

The students have identified their concerns. Are we prepared to listen? If we do, we will find they have given us a solution to many of the problems; ***professionalism***, ***humanitarianism*** and ***sensitivity*** to differences.

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FACTORS INFLUENCING UNDERGRADUATES CHOICE OF AREA OF SPECIALISATION AT A NIGERIAN UNIVERSITY

Indira Chacko

Cette étude avait pour objet d'identifier les contributions des quatre variables indépendantes (conditions d'entrée, débouchés, valeurs sociales et attentes des parents) à l'égard du choix du domaine de spécialisation à l'université. Des variations ont été observées dans chacune des facultés entre les femmes et les hommes, ainsi que dans les groupes du même sexe entre les facultés. Les variations totales expliquées par les variables indépendantes étaient pour la plupart supérieures à 37 %, à l'exception d'un seul groupe. Les débouchés et les attentes parentales sont d'importants facteurs contributifs dans le choix de spécialisation des garçons, alors que les conditions d'entrée et les valeurs sociales semblent des facteurs plus importants pour les filles. L'implication est que les conseillères et conseillers professionnels devraient travailler de concert avec les parents, les enseignantes et enseignants et les étudiantes et étudiants pour diriger ces derniers dans le cours le plus approprié, de façon à ce que les talents et les rares ressources ne soient pas gaspillés.

749

FACTORS INFLUENCING UNDERGRADUATES CHOICE OF AREA OF SPECIALISATION AT A NIGERIAN UNIVERSITY

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Abstract

This study was conducted to identify the contributions of each of the four independent variables, entry requirement, job opportunity, societal value and parental expectation to choice of area of specialisation at the university. Variations were observed within each of the faculties between females and males as well as with in the same sex group between faculties. Total variance explained by the independent variables were mostly above 37% except for one group. Job opportunity and parental expectation are important contributors for boys choice of major while entry requirement and societal value seem to be more important factors for girls. The implication is that career advisers should work with parents, teachers and students to direct the students to the right course of study, so that talents and scare resources won't be wasted.

Choice of area of specialisation at the undergraduate level, often leads to the choice of career. It could be rightly said that once a person enters a course of study, either by choice or by force, it more or less determines the careers that he or she could follow. This makes it necessary to find out the factors influencing the choice of course of study, so that students could be guided to make optimum use of their potential rather than to go into areas where they would get frustrated and waste their talents. Choosing an area that one is interested in and has the capacity to cope with, would be beneficial to the individual and economically viable to the nation, especially a developing nation, where resources are scarce.

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In Nigeria, probably like in many other places, entry requirements to courses is one of the factors that influence a person's choice of course of study at the university level. Societal value attached to the various careers, peer influence, parental demands and or expectations, job opportunities as well as well as conditions of service in various professions are some of the other factors that could influence the course of study.

In Nigeria of yester years, when the economy was buoyant, civil service jobs were looked upon as something lucrative and prestigious. A first degree, that is a B.A., B.Sc or B.Ed., was all that was needed to get into the civil service or to be snatched by prospective employers. Infact, then quite a number entered the university on scholarships or sponsorship from government or prospective employers.

By mid 80's, Nigerian economy took a downward plunge which led to the devaluation of the currency and consequent problems like unemployment and high cost of living. The changes in economy naturally affects the career aspirations of the youth. So civil service jobs are now abandoned for jobs in the private sector which attract better service conditions or self employment. Choice of careers in turn influence the choice of course. A good majority now try to get in for professional courses like medicine, agric, technology than for the pure sciences or arts.

The topic, choice of courses or majors at the undergraduate level is well researched into in the developed world (De Boer, 1984; Ethington and Wolfe, 1988; Ware and Lee, 1988; Stake, 1984) but here, not much work is done in this area with the exception of a few. For instance Uwadiae (1983) did a descriptive study of the factors influencing the choice of discipline of undergraduates of the University of Ibadan and Fabunmi (1992) looked at the contributions of the variables, parental expectation and self concept on career aspirations of undergraduates of the same university. Uwadiae reported employment opportunity as the most influencing factor in the choice of discipline while Fabunmi's study found self concept to be

more influential than parental expectation with regression weights of 0.61 and 0.13 respectively. Although there are some research reports on career aspirations (Obiri, 1977; Okediji, 1973; Olayinka, 1970) these are not connected to the undergraduates of any university in the country.

This research is an attempt to find out the contributions of each of the independent variables namely entry requirements, job opportunity, societal value, and parental expectation to students self rating and job aspiration forming the independent variable choice of major or area of specialisation.

Method

Sample.

Targeted and attained samples are given in table 1.

Table 1
Population and Sample

		Sample			
Faculty	Population	Targeted	Attained	Female	Male
Education	334	84	79	25	54
Science	500	125	28	15	13
Medicine	525	132	89	49	40

Around 25% of the fresh entrants in the faculties of education, science and medicine were administered a questionnaire on the background of the students and their reasons for choosing the course of study. Although the samples attained in the faculties of education and medicine are closer to the targeted sample, in the case of science, attained sample is too small. All same, this faculty too is included in the analysis because the entry requirements to medicine and education occupy the top and bottom of the ladder while that of the pure sciences keep to the middle.

Results and Discussion

Descriptive analysis of the variables age, desired occupation after graduation and the intentions to change the course and regression analysis of selected variables found to have some influence on the choice of area of specialisation follow.

Table 2
Distribution of sample by age

Faculty	Age in years								Total
	16 – 20		21 – 25		25 – 30		above 30		
	f	%	f	%	f	%	f	%	
Education	26	32.9	43	54.4	9	11.3	1	1.3	79
Science	20	71.4	7	25.0	–	–	1	3.6	28
Medicine	76	85.4	12	13.5	1	1.1	–	–	89
TOTAL:	122	62.2	62	31.6	10	5.1	2	1.0	196

The modal age group for education is 21-25 years while for the other two faculties it is 16-20 years. This implies that most of the students admitted into the sciences and medicine are younger, probably in their late teens and could be influenced by parents and others in their choice of course of study.

Table 3 gives the information on preferred occupation after gradation.

Table 3
Distribution of sample by desired occupation

Faculty	Teaching		Civil Service		Self employment		Private Sector		Any job		Other		Total
	f	%	f	%	f	%	f	%	f	%	f	%	
Education	7	8.9	12	15.2	29	36.7	23	29.1	2	2.5	6	7.6	79
Science	–	–	3	1.1	8	28.6	17	60.7			–	–	28
Medicine	–	–	9	1.0	49	55.1	21	23.6	2	2.2	8	9.0	89
Total	7	3.6	24	12.2	86	43.9	61	31.1	4	2.0	14	7.1	196

Those in the faculties of education and medicine prefer self- employment followed by jobs in private sector while those in the sciences prefer private sector jobs over others. Less than 9% of those in education opted for teaching. Self-employment is well practiced in medicine, but not in education. Those who opted for self-employment in education could start their own schools, provided the capital is available or get into business which is the 'in thing' now.

The third variable is 'the desire to change course of study, given the chance'.

Table 4
Distribution of sample by desire to change course of study

Faculty		Like to change course		Do not want to change		TOTAL		Total Sample
		Boys	Girls	Boys	Girls	Boys	Girls	
EDUCATION	f	10	26	15	28	25	54	79
	%	12.7	32.9	19.0	35.4	31.6	68.4	
	f	9	11	6	2	15	13	28
Science	%	32.1	39.3	21.4	7.1	53.6	46.4	
Medicine	f	24	14.0	22	29	46	43	89
	%	27	15.7	24.7	32.6	51.7	48.3	

Above 71% of students from the faculty of science, 45% from the faculty of education and 42% from medicine indicated their desire to change the course of study. In education and science, more girls (33% 39%) than boys (13%, 32%) indicated their desire to change the course of study while in medicine more boys (27%) than girls (16%) would like to change.

Those in education want to move to languages, arts and the sciences while those in the sciences desire to change to Technology, Medicine, Pharmacy and other science based professional courses. Those in medicine that indicated that they would like to change are in areas like Physiotherapy, Physiology and Dentistry and they desire to move to Human Medicine.

In the case of education, the trend observed by Uwadiae (1983) still persist. It is sad to notice that nearly 45% of those in education wants to change to other faculties and less than 10% only plan to take up teaching. This is an indication that a good majority come into the faculty of education not by choice but by chance. This is an area where career advisers need to work so that, as much as possible, students would be directed to areas where they have interest although entry requirement is a hurdle to be crossed.

754

The contributions of various factors that influence the choice of course of study is looked at by regressing the variables entry requirement, job opportunity, societal value and parental expectation on to the combination of the variables self rating and job aspiration, the results of which are presented in tables 5, 6 and 7.

Table 5
Regression analysis for Education

Variables	B weights	
	Girls	Boys
Entry requirement	0.9326	0.0908
Job opportunity	1.1072	0.1740
Societal Value	1.0968	1.0671
Parental expectation	0.1939	0.9162
Constant	8.7007	7.1318
R^2	0.44068	0.3896
N	54	25

For girls in education, the largest contribution comes from job opportunity (1.1072), followed by societal value (1.0968) and entry requirement (0.9326), while for boys, societal value (1.0671) and parental expectation (0.9162) account for most of the variance.

Total variance explained by the combination of independent variables for girls is 44.06% while for boys it is 38.96%.

The fact is that most enter education due to job opportunity as well as to their inability to meet up the entry requirements for a number of other courses which is partly supported by the results in table 5.

Society does not value or respect teaching profession yet the contribution of that is quite high. In the case of boys, parental expectation has a good weighting which seems to agree with the norms in the Nigerian Society where parents are more worried about their sons' than the daughters' career, mainly due to the assumed role of the males as bread winners as well as future supporters of parents in their old age. This also agrees with the findings of Dunman (1979)

Table 6
Regression analysis for Science

Variables	B weights	
	Girls	Boys
Entry requirement	1.8693	-0.1875
Job opportunity	-0.5093	3.0673
Societal value	-1.8001	0.1496
Parental expectation	0.8725	0.3034
Constant	9.5819	9.9095
R^2	0.6428	0.5837
N	13	15

For girls, the largest positive contributor is entry requirment (1.8693) followed by parental expectation (0.8725).

In the case of boys, job opportunity has the highest contribution (3.0673) followed by parental expectation (0.3034). The results obtained agree with the actual situation where the male student is keen on securing a job than the female. Students in the faculties of science and medicine come from more educated parents and their expectations could be higher hence the weights observed for this variable. Societal value is a negative contributor for girls with regression weight of -1.80 and for boys it is 0.15.

Total percentage contribution is 64.28 for girls and 58.37 for boys.

Table 7
Regression analysis for Medicine.

Variables	B Weights	
	Girls	Boys
Entry requirement	0.3691	2.4194
Job opportunity	-1.0222	0.7453
Societal value	1.0427	0.3125
Parental expectation	-0.1027	0.4948
Constant	18.8802	4.2498
R^2	0.0783	0.3747
N	42	44

In Medicine, for girls, the variable that has the highest positive contribution is societal value (1.0427) followed by entry qualification (0.3691). Parental expectation has a regression weight of –0.1027.

For boys, entry qualification has a weight of 2.4194 followed by job opportunity (0.7453). Societal value is the least contributor (0.3125) and all the variables contribute positively to the dependent variable.

Total variance accounted for is 7.83% for girls and 37.47% for boys.

Conclusion and implication

Between boys and girls, within each of the faculties, there is a lot of variation in the contributions of each of the four independent variables included in the study namely entry requirement, job opportunity, societal value and parental expection to the dependent variable, choice of course of study, formed by combining self rating and job aspirations.

However, in the case of education, societal value contributes equally well for girls and boys with B values of 1.0968, 1.0671 respectively.

For boys, in all the three faculties, job opportunity and parental expectation have positive contributions to the choice of course of study but in the case of girls, the contributions, of these vary from faculty to faculty.

Total variance explained by the combination of independent variables, vary with in and between faculties as well as within and between sexes. Highest variance accounted for is 64.28% for girls in science and lowest is for girls again in medicine with 7.83%.

While completing the questionnaires, a number of students in medicine mentioned that the factors listed for the choice of course were not relevant in their case and they were encouraged to list those factors that made them choose the course but this was not done. Probably this has affected the result.

The results indicate that the factors influencing choice of course of study depends on sex as well as on the subject area of study hence the need to conduct studies adding more factors based on the summary of personal interviews, and more faculties, which might bring out a clearer picture. The implication is that career advisers, parents, teachers and students should work together to direct talents to the right direction so that students do not end up in areas that they are not interested in.

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WOMEN'S WAYS OF KNOWING IN MATHEMATICS

Olive Chapman

Ce document est basé sur une étude que j'ai conduite avec un groupe d'étudiantes en première année de leurs études de premier cycle. Cette étude avait pour objectif d'examiner le rôle de l'expérience personnelle dans l'apprentissage des mathématiques. Les données, recueillies dans le cadre d'entrevues, d'observations en classe, de séances individuelles de résolution de problèmes et de données provenant de journaux personnels, ont été analysées dans un cadre explicatif. Les résultats de l'étude ont révélé que l'intuition de ces étudiantes pour résoudre des problèmes sous forme d'énoncés dans un contexte pertinent à leurs expériences personnelles était caractérisée par trois facteurs différents des approches traditionnelles face à la résolution des problèmes et aux interactions dans le domaine des mathématiques. Ces facteurs sont la connexité, un processus expérientiel descriptif de résolution des problèmes et une conception du contexte du problème en tant qu'expérience. L'étude suggère que pour enseigner les mathématiques plus efficacement aux femmes qui préfèrent une façon «rattachée» et «édifiée» d'acquisition des connaissances, le programme d'études devrait inclure des processus de groupe et de résolution de problèmes expérientiels.

WOMEN'S WAYS OF KNOWING IN MATHEMATICS

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ABSTRACT

This paper is based on a study I conducted with a group of female first year junior college students. The goal of the study was to investigate the role of personal experience in their learning of mathematics. The data, collected through interviews, classroom observation, group and individual problem solving sessions and personal journals, was analyzed in a qualitative interpretative framework. The outcome of the study showed that these students' way of knowing when solving word problems with context that was relevant to their personal experiences was characterized by three factors that are different from traditional approaches of problem solving and peer interactions in mathematics. These factors are connectedness, a narrative experiential problem solving process and a conception of problem context as experience. The study suggests that to teach mathematics more effectively to females who prefer a "connected" and "constructed" way of knowing the curriculum should include experiential group and problem solving processes.

INTRODUCTION

If females are to be encouraged to consider professional careers, particularly those in science, their participation in higher level mathematics becomes a critical issue. Mathematics has been and continues to be used as a "critical filter" (Sells 1976, Sherman 1982) into such careers. Thus females' dilemmas in mathematics warrant ongoing attention.

Gender differences in mathematics performance and participation, in favour of males beginning at the secondary level, and several factors (cognitive, affective, sociocultural) for their occurrence are well documented in the literature (for eg. Fennema 1985, Burton 1986). One area of concern has been problem solving tasks involving higher mathematical reasoning. When these tasks involve word problems, the content and context of these problems have been considered to be a significant contributor of the gender issue. There

have been studies that indicated that the context of a word problem could significantly affect females' performance depending on whether it reflected a male or a female oriented situation (Graf & Riddell 1972, Stein & Bailey 1973, Fox 1977). The argument here has been that word problems in mathematics were usually male oriented in that they often dealt with the physical world. Consequently, females, who apparently preferred situations involving interaction with people, not only found them to be impractical and uninteresting, but also difficult to interpret or fully understand because of their limited or lack of experience in such areas. Although such apparent stereotyping of women will likely be questioned today, there is continued support in the literature that women tend to prefer a relational way of making sense of their world (Gilligan 1982, Belenky et al 1986). Thus, although we must be sensitive to generalizations that could be self-defeating to women in general, we must also recognize that many women could be denied the opportunity to function in a mode they prefer if we ignore their unique features.

Belenky et al's separate and connected knowing have been promoted by some math educators (Buerk 1986, Brown 1984) as a way of understanding the inherent discrimination against females in the way mathematics is traditionally taught. My interest in these ways of knowing is in how they are actually manifested in the students' learning of mathematics particularly in solving word problems.

My experience with female students in my math classes led me to believe that many of them were engaging in processes, when solving word problems, that conflicted with those traditionally accepted in math. For example, they would base problem representation on contextual details, recall specific details as opposed to structural features of problems and make judgement of problem relatedness based on non-mathematical features. Such behaviours have been described in the literature as characteristics of poor problem solvers (Lester 1981, Suydam 1980, Silver & Smith 1980). Influenced by Gilligan's (1982) work, I decided that such explanations could be biased against females because they were interpreted in a framework that was not always consistent with females' ways of knowing. The traditional cognitive framework of investigating math behaviour was not capturing social experiences that seem to be influencing their treatment of word problems. The relevance of such

experiences is now supported by the changing climate in math education in the form of a growing body of literature that recognizes a social perspective of mathematics (D.Ambrosio 1986, Cobb 1986, Fasheh 1982, Bishop 1985, Ernest 1991). Thus the study I undertook investigated the ways in which the students' personal experiences and their ways of knowing were expressed in their learning of mathematics with specific focus on solving word problems.

RESEARCH PROCESS

The study involved three junior college female students (ages 18-19) enrolled in a business math course. Data was collected through open-ended interviews, classroom observations, group and individual problem solving sessions, and personal journals. The analysis involved various levels of comparisons between the students' social biography, math biography and problem solving behaviour in terms of teacher-student relationships, peer interaction and problem solving strategies.

SAMPLE DATA AND RESULTS

The significant outcome of the study involved the connectedness that emerged in the students' behaviour with respect to their group interactions while solving the word problems and their interactions with the problem context (discussed in more detail in Chapman, in press). This connectedness occurred only when the problem context was relevant to the students' personal experiences. The following is a sample of their group discussion while solving such a problem. [Because of the limitation on space, this abbreviated sample will not fully reflect the nature of the discussion that will follow it.]

Problem: A discount clothing store purchased raincoats for $36. The store requires a gross profit of 30% of the regular selling price. What price should be marked on the price tags of the raincoats if the store wants to offer a 25% discount without reducing its gross profit?
(...)
Marta: ....They have to inflate it 55% in order to take 25% off so they could still get a profit of 30%...

Lisa: That sounds right to me. This is why things are so expensive (laughter) because everyone is doing it.

Marta: That's why I don't buy anything unless it's on sale, especially from places like .....
(...)
Marta: Like last week at work, someone wanted to buy a watch, the price was $29.99. They ask me, "I don't have that much money, can't you give me a little bit better price?" ... I look at how much I will lose and said, "forget it!" because we paid so much for it and we can't reduce it more. But we don't inflate the price like this although it's a discount store too.
(...)
Janice: But if we look at it that they are giving a discount as a special, they don't have to inflate it that much.

Marta: But this is a discount store, so they usually do it, plus how else will they come up with 30% ...
(...)
Lisa: So what is he charging if we inflate it by 55%?

Marta: How much? Amm, 55.80?

Lisa: For a raincoat? (laughter) At a discount store?

Janice: But that's not what you pay because you get 25% off. Maybe it's only worth what you pay but they make it look like it's real quality. (laughter)

Marta: But that's still high! It doesn't make sense.

Lisa: But they will still be losing money if you do that.

Janice: They're not going to lose money. They can't lose money if they mark it for that much!

Lisa: For sure they will, because you end up paying 41.85 and they bought it for $36, that's only about $5 difference. It should be bigger.
(...)
Marta: But we have to know the regular selling price to find the profit. But we don't know that.

Lisa: No we don't. We don't have enough information.

Marta: That's why it would be safe to assume that they have to up the price 55% from the regular selling price, right? That's the only way that make sense.
(...)

The talk these students engaged in for situations like this was not representative of the

impersonal, context free, task oriented talk required in traditional math classrooms. It was a shift to a more personal framework. The students worked in an experiential mode depending more on their real life experiences to arrive at a solution instead of simply making abstract connections to what they had learnt in class. In this example, they shared their concerns about the "inflated prices" in a real world setting. They satisfied themselves that it was realistic to have inflated prices by sharing experiences related to such situations. They depended on the "social" context of the problem and of their personal experience to justify their concerns. In general, their behaviour or ways of knowing portrayed connectedness, a unique problem solving process and a different conception of problem context. The way in which each of these was manifested will be summarized in the remainder of this paper.

I. CONNECTEDNESS

Connectedness was manifested in the following ways:

1. There was a "surface level" connection through the solidarity of their behaviour and the harmony in what they shared. They pooled their experiences to get a unified outcome. They reinforced each other's position. They shared experiences that were similar in quality, almost like an imitation of each other's "story". In general, there was a "sameness" or a "oneness" about their interaction that was defining their connectedness.
2. There was an "inner" or personal level of connection; a "connection of self". This resulted from a sharing of "the personal"; experiences that defined them; autobiographical stories. These "stories", however, were not arbitrary, idle talk to merely satisfy a social purpose. They were rooted in the social context of the math problems, when it was relevant to their personal experiences, and provided a bridge between the experiential knowledge of their personal world and the abstract knowledge of the math world.
3. There was a connection with the problem context. When the problem context contained realities with which they were familiar, they seemed to look at the problem and see themselves in the context or reconstructed it to see themselves. For example, in doing the commercial business problems, they saw themselves shopping instead of seeing a problem about shopping. This created a situation of finding a solution to a personal experience. Thus

the reality of the problem became a critical concern as expressed in the sample data. This behaviour of seeing themselves inside the problem context contradicts the norm of one working with the context from the outside. The traditional approach would require the problem solver to accept the context as purely symbolic. It should be something external to him/her. It should be impersonal. It should be a tool -- something to be used to understand the problem -- to get to the mathematical relationship embedded in it, not something of which to become a part.

4. The above connections suggested a different purpose for the group context for learning mathematics. The group was important not just to complete a mathematical task, but to establish a social contract among the students to negotiate meaning on a personal level. This shift in purpose produced a shift in the nature of the social structure of the group from one in which the students were connected by a common task to one in which they were connected by shared personal experiences. The result was a group characterized by a sharing of self and a sharing of mathematical knowledge.

II. PROBLEM SOLVING PROCESS

The students' problem solving process was also somewhat unique. The process was not an impersonal application of algorithms or problem solving strategies to some phenomena (real or fictitious) embodied in the problem, external to themselves. The approach was not to focus on the mathematical context to understand the problem, but on the social context of the problem. In general, this approach depends on one's personal experience and the connectedness one can make to the problem context. Consequently, personal experience, personal meaning and social context are the most significant factors in solving the problems. These students used the story sharing mode to establish the connections between these factors. As each took turn to relate her connections and resonate in those of the others, they eventually reconstructed the problem based on their joint perceived reality of its context. This resulted in a constructed knowledge that provided them with a meaning of the problem and an appropriate solution.

The storying stage appeared to be one of "critical reflection" on the reality embodied in

their personal experiences called forth by the reality perceived in the problem context. Thus the resulting "personal constructed knowledge" is a social construction of a reality of the problem as it was experienced by each of them. It is an experiential reconstruction of the context of the problem. It is a reconstructed version of the original problem based on the "truths" extracted from their experience instead of those given in the problem. Thus it reflects what they cared about; their meaning; their reality.

In general, although the approach did not always lead to correct solutions, it seemed to help them to expand their ideas of the problem situation; to make sense of a mathematical experience; to reconstruct the problem to get a context that made math more relevant and meaningful; to see aspects of math that were suppressed in traditional approaches, thus resulting in a deeper appreciation and valuing of mathematics.

III. CONCEPTION OF PROBLEM CONTEXT

The students' treatment of the problems suggests a conception of problem context that is different from a traditional math conception. Traditionally, problem context is often treated as script and only the scripted story (the one intended by the author) is expected to be considered. Thus, for the student, it should be a description of an impersonal situation which clothes some mathematical abstraction. This requires a suppression of the students' story, a suppression of self, thus denying them the personal experience of the context. The students in this study violated these traditional boundaries by treating context as a personal experience; as an event already storied, or a restoring of one, in their life experiences. Thus the problem context is brought to life and take on the characteristic of similar real life experiences of the students. This conception suggests that they perceive mathematics not as a dehumanized process or skill to be mastered, but as a situation that is experienced in terms of human intention, fear, triumph, hope, etc. So one does not abstract the cognitive meanings from the human context, but deals with them holistically as a way of experiencing one's world.

CONCLUSION

The implication of the study is that if the experiential way of knowing expressed in these student's behaviour is not taken into consideration in the teaching of mathematics, many students, females in particular, will probably continue to be labelled negatively in their learning of mathematics and treated with meaningless doses of superficially modified traditional techniques to correct an otherwise natural behaviour. One must recognize that what we can know through experience and intuition we may not be able to know through abstract reasoning. Thus more attention should be given to researching this area in mathematics education and teachers should be educated to become more aware and more sensitive of these behaviours and how to deal with them.

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MARIAN SARAH PARKER SCHOLARS: A PIPELINE PROGRAM FOR UNDERGRADUATE WOMEN IN ENGINEERING

Cinda-Sue Davis and Carol Hollenshead

Aux États-Unis, les femmes reçoivent environ 16 % des baccalauréats en génie, mais seulement 4 % des doctorats. Le College of Engineering de l'University of Michigan, conjointement avec le Center for the Education for Women de l'University of Michigan, a mis sur pied un projet modèle novateur visant à aborder le problème du «plus on va haut moins il en reste». Le programme «Marian Sarah Parker Scholars», nommé ainsi en l'honneur de la première diplômée du College of Engineering de l'University of Michigan, comporte toute une série d'activités, à mettre en oeuvre dès les premières années d'études et tout au long des études supérieures. Ces activités comprennent des séminaires qui mettent l'accent sur les écoles du cycle supérieur et la carrière d'ingénieur; les stages de recherche; les groupes de soutien et de discussion sur les questions d'équilibre entre la vie professionnelle et la vie de famille et personnelle; et l'élaboration de présentations pour des symposiums, demandes de financement et prospectus de recherche.

Ce document traite des diverses composantes du Parker Scholar Program, ainsi que de l'élément d'évaluation. Le Marian Sarah Parker Scholars Program est financé par la National Science Foundation de l'University of Michigan.

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MARIAN SARAH PARKER SCHOLARS: A PIPELINE PROGRAM FOR UNDERGRADUATE WOMEN IN ENGINEERING

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ABSTRACT

Within the United States, women are awarded approximately 16% of the bachelor degrees in engineering, but only 4% of the doctorates. The University of Michigan College of Engineering, in collaboration with the U-M Center for the Education of Women, has designed and conducted an innovative model project to address the problem of "the higher the fewer". Entitled the "Marian Sarah Parker Scholars", named after the first woman graduate of the U-M College of Engineering, this program involves a comprehensive set of activities, which commence in the students' junior year and continue through the senior year. These activities include seminars focusing on graduate school and career issues in engineering; research internships; support and discussion groups designed to address work/family and related personal issues; and the preparation of symposia presentations, funding applications and research prospectuses.

This paper will discuss the various programmatic components of the Parker Scholar Program as well as the evaluation component. The Marian Sarah Parker Scholars Program is funded by the National Science Foundation and the University of Michigan.

INTRODUCTION AND GOALS:

Despite impressive increases in the number of women pursuing bachelor degrees in engineering over the past two decades, there remains a marked scarcity of women at the higher academic and professional rank, particularly in university research and teaching. To enter the professorial ranks in a research university, it is necessary to have a graduate degree, generally a Ph.D. Yet all too often, women engineering students elect not to continue their education onto the graduate level, thus effectively prohibiting them from academic careers. The problem of "the higher, the fewer" is still too prevalent.

Even at Michigan, one of only two universities in the United States to rank in the top ten in degree production at all three levels (bachelor, master, and Ph.D.), the overall numbers are most discouraging. Of 457 doctorates granted in the years from 1987 through 1990, women received only 25. This is of especial concern since during the same period, women received 629 of the total 2,724 bachelor degrees and 242 of the total 1,781 master degrees in Engineering at Michigan. At Michigan, as across the nation, we must take steps

to increase the number of women going on to graduate school after getting their bachelor degrees. This is the only way we can eliminate the problem of "the higher, the fewer".

The goal of the Pipeline Program, also known as the Marian Sarah Parker Scholars Program after the first woman graduate of the College of Engineering, is to increase the participation of women in academic research and related careers in engineering through the creation, testing, and evaluation and dissemination of a program for undergraduate women designed to encourage their entry into, and completion of, graduate study in these fields.

There are a number of reasons why undergraduates in engineering and the sciences do not go on to graduate schools. Students may think of graduate school as simply four to six more years of coursework and not as the preparation of autonomous professional (Widnall); they may not know how to finance graduate school; and the strong job market for bachelor degree recipients may make the financial payoff for graduate study almost non-existent and the prospect of foregone income unpalatable (Finkbeiner).

Even when women have been as successful as their male counterparts in their academic undergraduate programs, a variety of factors, external as well as internal, serve as barriers to their achievement. In spite of evidence to the contrary, women may be regarded as "affirmative action" students and seen as basically unqualified for scientific careers; consequently they receive little encouragement to seek the highest levels of attainment (Daniels). Women may also perceive the climate of their undergraduate program as hostile and inappropriately combative and hence antithetical to their values (Manis et al.) and they feel they must walk a tightrope between being regarded as too feminine or too aggressive. This experience may be compounded by the lack of female faculty role models and by the large number of engineering and scientific faculty from cultures that do not generally favor the entrance of women into professional life (Daniels). Women who contemplate graduate education may have difficulty obtaining sufficient financial support to continue their education, in spite of the available resources. Women perceive that they receive less emotional support from their families for their career decisions than do men (Oggins et al.). Finally, women's perceptions of their own abilities may differ from those of their male counterparts; even when objective measures of achievement are equal, women may exhibit lower self-esteem and underestimate their potential for graduate study (Eccles). In a

University of Michigan survey, women in science were less likely than men to feel that they had a strong background in science (Manis, et al.).

The Pipeline program incorporates components designed to: (1) familiarize students with the graduate education process and with research careers in engineering; (2) build participants into a supportive academic community; (3) deliver appropriate support and guidance; and (4) facilitate the personal and professional growth of Pipeline Program students. Program components include; (1) the identification and nomination of "likely to succeed" women to the honors Pipeline Program; (2) formal seminars focusing on career issues in engineering; (3) internships followed by a research symposium (4) a formal seminar focusing on graduate school issues; (5) support and discussion groups designed to address personal conflicts and work/family issues; and (6) preparation of a research prospectus to be used in the graduate school application process.

PROGRAM DESCRIPTIONS AND STRATEGIES

Women and men may achieve equally well academically, and they may be equally focused on a particular career pathway, but they make their decisions in a very different social climates and with different value systems in mind. Women consider a number of different factors when deciding to enter or continue in a traditionally "male" field. Issues of self-confidence, and self-esteem, the problems of combining personal and professional lives, accessing networks, acquiring mentors, and learning how the system works are only a few of the concerns which women, and the academic programs designed to serve them, must address.

Nomination of Participants. We estimate that up to 50% of the female undergraduates are qualified to continue to graduate school but only a small fraction of this number do so. All potential participants in the Pipeline program are nominated in the fall term of their junior year in one of four ways: (1) College of Engineering faculty members teaching junior students are asked to identify and nominate 2 to 5 women students for the program. This faculty nomination process has several desirable effects. It makes the faculty think consciously about women students and their potential for graduate study. In addition, it bolsters the self-confidence and self-esteem of the women students themselves.

(2) Professional societies and organizations within the College of Engineering, specifically the Minority Engineering Program and the Society of Women Engineers, nominate those women who display exceptional talent during their freshman and sophomore years. (3) The Pipeline program is advertised through direct mailing and through College of Engineering information systems. Women who are considering graduate school and wish to participate will be able to nominate themselves. (4) The last nomination process is through an examination of the academic records of the top women students, specifically those with a grade point average of 3.0 or above (out of a total of 4.0). All identified students, regardless of the method of nomination, are mailed a special letter of invitation by the Associate Dean of the College of Engineering.

The Fall Term Seminar Series. Pipeline participants participate in a weekly seminar series throughout the Fall Term for a total of five sessions. The beginning of the series recognizes and acknowledges the graduate school potential of all the participants. We address factors that women consider when deciding to enter and pursue careers in traditionally male fields.

During the next five seminar sessions, professional women engineers and graduate engineering students, representing various engineering disciplines and careers, are invited to discuss their various fields of study. The are asked to describe the process of how they decided to go on to graduate study, how and why they selected their graduate school, and what they envision they will be able to do in their careers that they wouldn't have been able to do without a graduate degree. Not only do the pipeline participants learn a great deal from this process, they also are able to interact with some excellent female role models, a rarity for women in Engineering. While the professional engineers address the same issues as the graduate students do, they do so from an advanced professional standing. They give the students a perspective on the graduate school environment and experience from the point of view of women who have successfully negotiated it and are now established in the professional community.

Winter Term Planning Your Future Groups. As the second term of the junior year commences, students are ready to begin to address the need for effective personal planning.

At this point, students are divided into smaller discussion groups called "Planning Your Future" led by trained counselor/facilitators. Over a four-week period these groups will discuss issues such as how to maintain effective relationships with faculty and mentors, how to build a peer support network, and how to accurately assess one's own talents and strengths. Participants are expected to complete an informational interview with a professional engineer or researcher in the subfield of engineering in which she is most interested. Another purpose of the groups is to help ensure that peer relationships and networks are built for mutual support. Issues pertaining to women's development and self-esteem are also addressed.

Because research has demonstrated that developmental issues, family backgrounds and hope for marriage and family all play a very significant role in the career decision process for women, in-depth discussion of the issues and concerns surrounding combining one's personal and professional life is an important component of these groups.

Winter-Term Workshops. Following the Planning Your Future groups, a half-day Saturday workshop covering the application process to graduate school is conducted for all participants. Strategies are presented to students on how to determine the best graduate programs, both in terms of academic reputation as well the "climate" for women. General information about financial aid, such as sources, the benefits of a research versus a teaching assistantship, and the value of external fellowships in addition to departmental support is discussed. Sample NSF graduate fellowship proposals are presented. Discussion on networking as well as finding and cultivating a mentor relationship is presented. The importance of obtaining appropriate letters of recommendation and how to do this is outlined. Sexual harassment and discrimination is discussed. Panelists for this workshop typically include financial aid officers from the Rackham School of Graduate Studies, Associate Deans from the College of Engineering, Chairs of Engineering graduate student selection committees and Engineering faculty members.

A second workshop, entitled "Moms in Science and Engineering", is also offered in the spring term. Panelists for this presentation included women faculty members and graduate students in science and engineering who are also mothers. Strategies for juggling a personal and professional life are presented. Every effort is made to insure a wide

diversity of mothers, in terms of ethnicity, ages and number of children, sexual orientation (lesbian mothers are included) and life situation (single parents are included).

Summer Term, Junior Year: Internship Program. One of the most effective strategies for women with uncertainties about career goals and potentially low esteem is the completion of a successful professional experience. As Humphreys points out "One of the best ways to develop motivated an competitive graduate applicants is by offering research opportunities to undergraduates" (p 774). Independent research and the resultant interaction with graduate students and the support and encouragement of a faculty mentor are invaluable. Therefore all Pipeline Program participants are given an opportunity to participate in a four-week summer internship program in laboratories within the College of Engineering or in local industry. Students are expected to work 40 hours a week and receive a $1,000 US stipend. This portion is funded through a combination of University of Michigan matching funds and NSF Career Access Model Project funds (our outside funding source).

The internship component provides the opportunity to work directly with a faculty mentor and to gain a clearer understanding of the academic research process and social milieu of the laboratory. During the internship period, students also meet as a group to discuss issues of mutual concern and to build an academic support network.

If a participant is unable to remain in the Ann Arbor area for the four-week period during the Summer Term, a research project during her senior academic year is arranged. Several interns have continued working in their mentors laboratory after the internship period is complete.

The Senior Year: The Application Process. The senior year is when students apply for graduate school and for fellowships. Pipeline Program staff are available for one-on-one counseling, answering questions and providing assistance during the application process. Opportunities for interviewing are scheduled with those graduate schools which come annually to recruit. Interviewing techniques are discussed and practiced. Students are encouraged to share interviewing experiences with one another.

At the end of the senior year, a recognition event and celebration is held. Students are honored at this time. Faculty mentors, parents, program staff and faculty are invited to attend to recognize the students' accomplishments.

Successful completion of the Marian Sarah Parker Pipeline Program is noted on the academic transcripts of all participants.

Evaluation. A comprehensive program evaluation is currently being undertaken At the onset of the program baseline data on all participants was gathered. This included data from student records (GPAs, SAT scores, etc.) as well as data collected directly from program participants designed to assess such factors as career plans, self assessment and self-esteem. Throughout the program, participants' academic performance is being monitored and recorded. Data, including repeat measures, will be again collected from participants at the end of the senior year (May, 1993). Comparisons will be made with appropriate groups: male students, women who met Pipeline Program academic standards but did not participate or who left the Program, and with records of previous classes of women in the College of Engineering. Complete evaluation of the first year of Pipeline participants should be complete by December of 1993.

CONCLUSION

The University of Michigan Pipeline Program is currently in its second year. Although it is too early to evaluate the success of the program, it clear that student interest and participation is overwhelmingly enthusiastic. Parker Scholars feel honored to be asked to participate and over 90% of the first year participants completed all of the above described activities, despite very demanding academic schedules. Many participants have commented that this is the first time that they have had the opportunity to meet other women in engineering, both at the student and faculty level. They also report that they feel that the University is demonstrating a genuine concern for their academic and professional achievement and success. This sense of concern can be all too rare in a large, impersonal research university setting.

It is imperative that individuals interested in gender issues in science and engineering education look at issues along the entire educational pipeline - from preschool

through graduate school. Too often our focus is at the earlier levels of elementary and secondary education as well as the first year of college. Although these do represent crucial points for intervention, the passage from undergraduate to graduate school is also very critical. It is only by increasing women's participation in graduate education can we hope to significantly increase the number of women in our university faculties.

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FEMINIST PEDAGOGY IN THE PHYSICAL SCIENCES: A RESEARCH REPORT

Fran Davis and Arlene Steiger

L'hypothèse de ce projet de recherche de trois ans, financé par le ministère de l'Éducation du Québec (PAREA), est que la pédagogie féministe peut produire des étudiantes plus actives, plus confiantes et plus engagées à l'égard des programmes de physique postsecondaires. Un ensemble intégré de stratégies pédagogiques féministes a été développé, sur la base d'une étude des modèles pédagogiques et des styles d'apprentissage des femmes. Les recherches ont compris quatre semestres d'expérimentation, dans le cadre desquels les attitudes et les accomplissements des étudiantes de deux sections de physique collégiales ont été comparés à ceux des étudiantes de classes de référence parallèles, à l'aide d'un ensemble intégré de stratégies pédagogiques féministes.

L'analyse semestrielle des données quantitatives et qualitatives a révélé, de façon typique, des différences importantes dans les attitudes et comportements des étudiantes et étudiants et entre les groupes d'étudiantes et étudiants expérimental et de référence. On propose également quelques suggestions pour de futures recherches.

FEMINIST PEDAGOGY IN THE PHYSICAL SCIENCES: A RESEARCH REPORT

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ABSTRACT

The hypothesis of this three-year research project, funded by the Quebec Ministry of Education (PAREA), has been that feminist pedagogy can produce more active, confident and committed women students of post-secondary physics. An integrated set of feminist teaching strategies has been developed in accordance with a study of the research on the educational patterns and learning styles of women. The research design has involved four semesters of experimentation, in which the attitudes and achievement of students in two sections of college physics, involving the use of an integrated set of feminist pedagogical strategies, are compared with those of students in parallel control classes.

The semester-by-semester analysis of both quantitative and qualitative data has consistently shown significant differences in student attitudes and behaviours, both between females and males and between the experimental and control groups of students. Directions for future research are also suggested.

The research in which we have been involved is focussed very closely upon the nature of the educational experience for women. The scrutiny of this process is vital for many reasons.

Educational attainment is, for women, more firmly linked to labour force participation and a chance to escape poverty than is the educational attainment of men (Statistics Canada, 1989). Nevertheless, the general educational pattern of women continues to be distinguished from that of men by women's tendency to drop out of the system in greater numbers at higher levels (Canada, 1991). This statistical pattern emerges much more dramatically in the sciences, even though women's achievement rates in science and math have been equal to those of their male counterparts (Lafortune, 1986). The registration of women in post-graduate programs in applied and physical sciences remains disproportion-

ately low; these figures have increased only marginally since 1975, and at nowhere near the rate which would suggest that women are likely to gain access to academic decision-making positions in these disciplines (Canada 1991).

Given this lack of educational preparation, women continue to miss opportunities to pursue employment in science and science-related fields, areas which are increasingly the most likely to offer them permanent earning power (Lafortune, 1986). As the students themselves acknowledge, studying science keeps their options open (Davis and Steiger, 1992), as science fields are those which enforce pre-requisites, as many other disciplines do not. Researchers have noted, however, that the traditional core of science students are drawn into and through the sciences by motives which have much more to do with career ambition and their vision of themselves than with their actual experience of their courses (Tobias, 1989). Women, however, less committed to these careers and much less encouraged to pursue them, may be more sensitive to educational experiences which they (and frequently men as well) qualify as negative.

The challenge has been how to redesign traditional pedagogy to allow women students opportunities for intellectual development equal to those of men. Seeking to formulate a set of feminist teaching strategies that could be utilized in existing science curricula, we have looked to a solid framework of research findings on gender differences in this domain.

Research on the speech patterns of women shows that, in large mixed groups such as classrooms, women speak less frequently, more hesitantly and are more likely to be interrupted than are men (Rich, 1979; Spender, 1980). Teachers, even feminists, appear to contribute to this process by according more time and attention to the intervention of males (Serbin and O'Leary, 1975; Laforce, 1987; Concordia University, 1991). These patterns of behaviour are all the more serious when we consider the role of language in the

acquisition of knowledge, a point emphasized by educational researchers in literacy across the curriculum (Fulwiler, 1980; Martin, 1976; Shor, 1987) as well as in specific disciplines like biological and physical science (Brooke and Driver, 1986; White, 1988) and mathematics (Baruk, 1985).

Second, to the extent that the classroom situation is hierarchical and emphasizes competition either in terms of performance in class or through evaluation techniques, men and women do not receive equal education, since substantial evidence suggests that women's performance decreases as the level of competition increases (Horner, 1969; Spender, 1980; Gilligan, 1982; Lafortune, 1986). In fact, research on women's speech patterns (Spender, 1980), as well as the work that has been done on their moral development (Gilligan, 1980), suggests that women perform better in situations which favour cooperation.

Third, since research suggests that females value human relationships over abstract principles (Rich, 1979; Gilligan, 1982; Bunch and Pollack, 1983; Laforce, 1987), the exclusively rational approaches of science are experienced as alienating and intimidating by many women (Lafortune, 1986).

In order to accommodate these needs, that is, the need for access to the discourse of the classroom, the need for a more collaborative working atmosphere, and the need for the inclusion of affective and personal experiences, we have elaborated and trained teachers in the use of three principal strategies: spontaneous and uncorrected kinds of student writing in the learning process, freely chosen and permanent student peer support partnerships, and systematic self-disclosure by the teacher. It is this set of feminist teaching strategies which we tested in a multi-disciplinary study in 1988-1989 (Davis, Steiger and Tennenhouse, 1990), and which we have been testing for the past three years in college physics classrooms.

The overall hypothesis of the three-year research project which we are now completing has been that feminist pedagogy can produce more active, confident, and committed female physics students. The research design has involved four semesters of experimentation, in which the attitudes and achievement of students in two sections of college physics, involving the use of feminist pedagogical strategies, are compared with those of students in parallel control classes. The data examined has included pre-and post-semester attitude surveys, attendance and office appointment records, interviews of students by the researchers, and records of drop-outs, failures and final grades. Student written work and teacher and student evaluations of the strategies have also been examined. Since we have only just begun to assemble the data, we cannot produce meaningful tables at this time: however, the trends are now very clear.

The results of the attitude survey have, over the four semesters, shown consistent significant differences between control and experimental groups in three different areas: attitude to teacher, anxiety level, and enjoyment of physics. Feminist pedagogy significantly improves attitudes toward the teacher, reduces learning anxiety levels, and increases the enjoyment of physics. To this extent, then, we can tentatively conclude that the treatment may in fact be increasing confidence, engagement and commitment of women students as we hypothesized at the outset.

However, this data also contains significant gender differences, inasmuch as the anxiety of males is reduced to a greater extent than is that of females, and the enjoyment of physics is more greatly enhanced for the males by the strategies than is the enjoyment of the women students. We also note that on the other three sub-scales of the survey, that is, the value of physics, the student self-concept with respect to physics, and the motivation to work at physics, men consistently score higher in all groups than do women. In other words, we observe a strong and continued resistance by women to physics, only partially ameliorated by the feminist interventions.

Achievement data and class attendance have shown no significant differences, with respect to gender, attitude or experimental treatment. Office appointment records, however, are significantly different with respect to gender. Women students elect to see their teachers much more frequently than do males. For us, this data echoes the research which suggests women's preferred learning style includes such connectedness (Belenky et al, 1986), and it indicates that if teachers do not make themselves available and accessible for consultation, women students are particularly disadvantaged.

Student and teacher reactions to the interventions have been mainly positive. Virtually all female respondents have been enthusiastic about peer support partnerships, as have 90% of the males. The few objections by the males have come from highly competitive individualistic learners, or low achieving males who are deeply distrustful of themselves and their fellow students. Teachers have agreed that these partnerships work well and change the atmosphere of the class. The writing has had a more mixed response. Although teachers have felt less overwhelmed by the reading of this material than we expected, telling us that the insights it gives are worth the time, some teachers have found it difficult to sustain the discipline of integrating regular submissions of student writing into the theoretical and problem-solving aspects of the course. When this happens, students seem to benefit less. Women students have been more likely to evaluate the writing positively. Many women and some men students commented on the way in which such writing gave them regular access to the teacher's attention, and the written work shows students struggling both to express their problems in their own language and to master the language of physics itself.

The interview schedule is designed to capture, in a more reflective fashion than the written survey can, the confidence, involvement and commitment of the student as she enters the course, and to ascertain whether these attitudes change during the course of the semester. This interview data has helped us interpret our other findings. One of the more

persistent themes of this material is that doing physics requires hard work. We have encountered overwhelming faith in the connection between hard work, disciplined effort and success, and substantial agreement that success in this area carries with it considerable prestige. Male students seem much more willing to predict this success for themselves, and to minimize the importance of any difficulties they might be having by saying "I didn't work hard enough this term, but I'm going to change that." Perhaps because their career visions of themselves seem much more restricted to areas such as medicine and health, we observe less tenacity to physics in itself among the women students, much more trouble with decontextualized theory, and much less certainty about their ability to do the work.

The importance of the teacher is another recurrent theme, elaborated upon by both women and men. The women, however, appear to react to difficulties with teachers with much greater personal vulnerability: males may express anger and disappointment with what they called "poor teaching," but the women are much more likely to say that the teacher "made me feel stupid."

As we burrow more deeply into these and other comments, we begin to touch upon the many complexities of assessing student confidence, an area with which we, along with many researchers (Meece 1982; Mura 1986; Lafortune 1986), have been concerned. Our interviews have confirmed for us the extent to which students conflate competence with confidence. The hesitance, on the part of many women students, to claim either confidence or competence, has led us to consider, with such researchers as Heatherington et al (1989), the social consequences of such a stance for females, and the extent to which an expression of confidence may be compulsory male bravado. These considerations have led us, in turn, to theorists who have suggested that the suppression of self-doubt is central to the ideology of science education (Hacker, 1989) and that this notion is masculine in that it is oriented to a particular and gendered system of maintaining distance, and control

(Keller, 1985). If confidence is a masculine construct and thought to be synonymous with success in science, the implications for women are enormous. As Australian researchers Kenway and Willis (1990) write, "seeking to raise self-esteem within the terms of the educational and social status quo may well have the effect of underscoring the dominant sex, class, and ethnic groups of society" (p. 11-12).

Clearly, there remain aspects of women's educational experience which these feminist strategies have not sufficiently addressed, and the next stage of our research moves into this domain. We have been struck by the gendered nature of science education and the ways in which even well-intentioned researchers have themselves been drawn into masculinist categories and interpretations. We are, however, heartened by the range of significant effects which we are presently tabulating, and we are convinced of the extent to which even small changes in pedagogy can impact positively on women.

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ENCOURAGING WOMEN TO BECOME TECHNOLOGICAL TEACHERS

Rina Doron

Le principal objectif du Center for Technological Education, Holon (CTEH), est de former les enseignantes et enseignants au système d'éducation technologique. On a découvert que 33 % de ses diplômées et 17,2 % de ses diplômés choisissaient une profession dans l'enseignement (Doron, 1988). Vu que le pourcentage des femmes étudiant au CTEH est relativement bas (22 %) par rapport à celui des hommes (78 %), et vu la tendance plus prononcée des femmes à se tourner vers l'enseignement, un effort devrait être déployé pour encourager les femmes à étudier et à se qualifier dans le domaine de l'enseignement de la technologie. Ce document présente les principaux résultats d'une enquête conduite auprès de la population des étudiantes du CTEH, visant à expliquer les raisons pour lesquelles les femmes s'inscrivent au CTEH, les problèmes auxquels elles doivent faire face dans le cadre de leurs études et ce que l'on peut faire pour améliorer leur situation, leurs attitudes et leurs aspirations à l'égard de l'emploi, et ce qui devrait être fait pour accroître la représentation des femmes au CTEH. Les étudiantes du programme de conception industrielle constituaient 52,1 % de ce département. Il semble que les «nouvelles» professions technologiques auxquelles aucun stéréotype sexuel n'est encore rattaché attirent plus de femmes que les professions technologiques traditionnelles, telles que l'électricité et l'électronique (7,6 % des femmes), la mécanique et le contrôle (7,5 % des femmes). Par conséquent, on a décidé de mettre l'accent sur le petit nombre de femmes (23) étudiant ces sujets.

ENCOURAGING WOMEN TO BECOME TECHNOLOGICAL TEACHERS

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ABSTRACT

The main aim of the Center for Technological Education, Holon (CTEH) is to train teachers for the technological education system. It was found that 33% of its women graduates and 17.2% of its male graduates actually turn to educational occupations (Doron, 1988). In view of the fact that the proportion of female students at the CTEH is relatively low (22%) in comparison to that of male students (78%), and the higher inclination of women towards teaching, an effort should be made to encourage women to study and qualify for technological education. The present paper presents the main findings of a survey conducted on the female student population of the CTEH to ascertain the reasons why women apply to the CTEH, the problems facing women during their studies and what can be done in order to improve their study conditions, their attitudes and aspirations regarding employment, and what should be done to increase the representation of women at the CTEH. Female Industrial Design students constituted 52.1% in that department: It appears that "new" technological professions that do not have any gender stereotype attached to them, attract more women than the conventional technological professions such as Electricity and Electronics (7.6% women), and Mechanics and Control (7.5% women). It was, therefore, decided to focus on the small population of women (23) studying these latter subjects.

BACKGROUND

The main aim of the Center for Technological Education, Holon (CTEH), which is affiliated to Tel-Aviv University, is to train teachers for the technological education system. On graduating, students receive both the B.Sc.T.E. Degree (Bachelor of Science in Technological Education) and a teaching certificate awarded by Tel Aviv University. This certificate qualifies him/her to teach technological subjects at the post-primary and post-secondary level. The duration of the regular full-time course of studies is four years but a part-time "flexible" framework is available for Electricity and Electronics students and those studying Mechanics and Control should they wish to spread their studies over a longer period (up to five and a half

years). This special study program is designed to accommodate those students who are unable to attend the day-study program such as working students (e.g. teachers in the technological education system, those employed in industry and the services), regular army personnel, and mothers of small children.

A follow-up study of CTEH students graduating from 1976 to 1984 (Doron, 1988; Doron, 1991; Doron, in press) found that 33% of the women graduates were employed in educational occupations although their proportion in the follow-up population was only 22%. Furthermore, only 17.2% of the male graduates were employed in teaching occupations although they constituted 78% of the follow-up population. These findings are in support of the view that women show a preference for teaching and, therefore, should be encouraged to study and train towards technological education. The timetable, compatible with school-aged children, constitutes an important factor in the attraction of teaching for women (Zack & Horowitz, 1985). Research conducted by Lortie (1975) found that over half of the women stressed convenience as the reason for being attracted to teaching. In Israel, women constituted 85% of those obtaining a teaching certificate in 1991 (Central Bureau of Statistics, 1992). The proportion of women enrolled as students at the CTEH is relatively low (23.1% in 1992). Although 52% of the students in the Industrial Design track are women, in the Electricity and Electronics track and in the Mechanics and Control track, their proportion is only 7.6% and 7.5%, respectively.

In 1984 and 1985, women constituted 13.8% of Israel's engineering students (Rom, 1991). The increase in this proportion over the past six years can hardly be seen as significant. According to the data of the Central Bureau of Statistics (1992), the proportion of women among 1990/91 engineering graduates in all the institutions of higher education in Israel reached only 16.6% (Mechanical Engineering, 5.4%, Electrical Engineering, 6.9%, and Architecture, Urban Planning and Landscape Architecture, 55.7%). Many researchers in Israel have focused

on this issue over the past 20 years (Doron, 1972a; Doron, 1972b). On the one hand, it is clearly in the interest of society to exploit the intellectual ability of women in present and future technological areas and, on the other, these areas are essential to the learning and understanding processes of each and every individual. Thus, the technological component in education should be strengthened, and equal opportunity be made available to all citizens, irrespective of gender or origin.

Many women, however, are apparently deterred by the very idea of daring to attempt penetrate a learning or occupational area in which they will find themselves to be a minority. They tend to draw conclusions on their chances of succeeding in these areas merely on the basis of the minority status of women in them. More often than not, the prejudices that prevail regarding the chances of women succeeding in many areas stem from their absence in these areas for reasons that are purely socio-historical. Research findings in Israel (Rom, 1991), however, have shown that when women do embark on engineering studies, their achievements are higher than those of men. An important factor deterring women from technological studies is concern about the chances of their absorption into the work market. It is reasonable to assume that economic forces are a crucial factor in this respect. As an example one can cite the demand in Israel in the 70s and 80s for computer science graduates - As a "new" profession, free of gender stereotyping, women were readily accepted and absorbed into this field. However, the relatively small numbers of women currently in mechanics and the electrical professions cannot be an attractive or encouraging factor for young women. Thus, one should assess ways to recruit women to qualify for technological teaching who, in turn, will serve as identification models for female students at the post-primary and post-secondary levels. In this way, girls will be better able to perceive themselves as suited to the technological professions and technological teaching.

In the Israeli context, one should mention the massive immigration from the Soviet Union that has taken place since the end of 1989. About 400,000 immigrants have arrived in Israel in recent years 65,000 of whom have been absorbed into Israel's educational institutions. The tendency of women from the Soviet Union to study technological subjects is well known (Blekher, 1979). Thus, one should exploit the fact that among the women immigrants, there are many who are qualified in engineering subjects and can be directed to technological teaching.

METHODOLOGY

In view of the above, it was decided to conduct a survey among the female students of the CTEH to ascertain their reasons for choosing to study at the CTEH, the problems facing them during their studies and what can be done to improve their study conditions, their attitudes and aspirations regarding employment, and what can be done to increase the representation of women at the CTEH.

The questionnaire was sent to all of the 108 female students enrolled at the CTEH in 1992. The response rate was 4 out of the 5 studying Mechanics and Control; 16 out of the 18 studying Electricity and Electronics, and of the 85 female students studying Industrial Design (52% of all students in that department) only 3 answered giving the following typical response: "In the design professions the subject of "women" is a non-issue." It seems that the "new" technological professions, such as Industrial Design and Computers, which do not have a gender-stereotype, attract women more than the conventional technological professions such as Electricity, Electronics, Mechanics and Control. It was, therefore, decided that the survey would focus on the small population of women studying Electricity and Electronics, and Mechanics and Control. Of the 23 female students enrolled in these tracks, 20 (87%) responded to the questionnaire.

RESULTS

Characteristics of Female Students at the CTEH

Sixty percent were Israeli-born, 5% were veteran immigrants, and

35% were new immigrants from the USSR (not more than 3 years in Israel). Seventy percent studied in the full-day regular course and 30%, in the part-time "flexible" course. Most of the students (65%) were 21-25 years old. 20% were 26-30 years old, 10% were over 30, and 5% were under 20. Fifty-three percent were unmarried, 37% were married, and 10% were divorced. Seventy-five percent had no children, 12% had one child, and 6% had two children (one was pregnant). The arrangement for the children of these student mothers was usually nursery school or school, only one of the respondents reporting no regular arrangement. The most common source of financial support for studies was parents, scholarships and other (unspecified) sources. About 50% did not work and the rest were in salaried employment. Only one reported being self-employed. Employment was divided equally between technological and non-technological occupations (4 in each) and only 2 were employed in teaching or instruction. Approximately 44% had a technological education background: 19% in technological subjects and 25% as technicians or practical engineers. About 25% had specialized in the Biological Sciences, 19% in the Physical Sciences, and 12% in the Humanities.

Attitude of the Environment to Study at the CTEH

The students were asked about the attitude of their parents, spouses, and fellow students to their studying at the CTEH. All mothers and all fathers (except for one) were reported as relating positively to their daughters' studies. Husbands and most of the students' friends, male and female, (93%) were also reported as relating positively to their chosen course of study.

Occupational Background of the Students

To the question "Have you ever been employed in a technological occupation?" 7 gave a negative answer and among those answering in the affirmative, half had been employed in technological roles during their military service, and the other half had worked in a civilian framework. Only 8 had ever worked in the field of education. In answer

to our question whether work in a technological occupation in the past had influenced their decision to study at to the CTEH, 39% answered in the affirmative, and to the question whether employment in education or teaching had influenced their decision to apply to the CTEH, only 18% answered that it had.

Future Career Plans

Nine students expressed the wish to become technological teachers. The remainder saw their studies as means of getting a higher degree or working in a technological profession rather than teaching.

Attitude to Technological Studies and Education Studies

Table 1 shows the distribution of responses of female students to five statements expressing attitudes towards their studies.

Table 1
Distribution of Responses to Statements about Attitudes to Technological and Education Studies (in percent)

Response / Subject	Disagree completely	Disagree	Agree	Agree completely	Total %	Total N
"I have to work harder than the male students in the class to get the same grades"						
Technol.	63.2	15.8	10.5	10.5	100.0	19
Education	68.4	31.6	-	-	100.0	19
"Sometimes I think that the male students feel uncomfortable about having me in the class because I am a woman"						
Technol.	50.0	38.8	5.6	5.6	100.0	18
Education	57.9	42.1	-	-	100.0	19
"Some teachers do not relate to me fairly because I am a woman"						
Technol.	50.0	27.8	22.2	-	100.0	18
Education	55.5	44.5	-	-	100.0	18
"I feel discriminated against in my grades in comparison to the men"						
Technol.	63.1	31.6	5.3	-	100.0	19
Education	68.4	31.6	-	-	100.0	19
"I don't feel comfortable asking questions and speaking up in class"						
Technol.	47.4	26.3	10.5	15.8	100.0	19
Education	63.1	26.3	5.3	5.3	100.0	19

Chi-squared tests to examine the hypothesis that there is no difference between the distributions of responses to the the statements regarding the technological subjects and education subjects were not statistically significant.

As can be seen in Table 1, most of the female students do not feel discriminated against either by their teachers or by their male

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discriminated against either by their teachers or by their male colleagues, neither in the technological subjects nor the education subjects. However, the rate of feelings of discrimination due to being a woman is higher in technological studies than in education studies. Although this rate does not exceed 25%, it should not be ignored.

Most of the respondents considered the learning material to be of medium difficulty both in technological and education studies and about 95% considered themselves to be good students. Eighty-four percent noted no difficulty in performing technical activities related to the studies. In general, 95% noted that they were satisfied with their decision to study technological subjects.

Social Aspect of Studies

It is commonly believed that women who constitute a minority in a population of men either feel socially isolated, or, alternatively, overly popular: In our survey, 63% reported enjoying being a minority in a class of men. To our question: "Would you feel more comfortable if there were more women in the class?" 44% answered in the affirmative and 56% in the negative. Thus, for the majority, the gender composition of the class was of no significance.

Career Expectations

Table 2, which presents responses to statements regarding career expectations, shows that whereas 80% thought that it would be difficult for them to find work in engineering, 94% thought they would have no difficulty in finding teaching work. With regard to supervision roles, in engineering, 70% were anxious about the reactions of men whereas in education, only 25% expressed anxiety.

The level of anxiety regarding the attitude of other women was found to be similar in both engineering and teaching (30% and 25%, respectively). Anxieties regarding careers undoubtedly do exist and act as a deterrent. In general, female students believed that "life will be easier in teaching".

Table 2

Distribution of Responses of Female Students to Statements Expressing Attitudes to Future Career (in percent)

"It will be difficult for me to find work because I am a woman"

Response / Subject	Disagree completely	Disagree	Agree	Agree completely	Total %	Total N
Engineer	5.0	15.0	60.0	20.0	100.0	20
Teacher	37.5	56.3	6.2	-	100.0	16
"I am worried how men will react if I have to supervise them"						
Engineer	-	30.0	45.0	25.0	100.0	20
Teacher	18.7	56.3	25.0	-	100.0	16
"I am worried about the attitude of other women to me at work"						
Engineer	35.0	35.0	25.0	5.0	100.0	16
Teacher	37.5	37.5	25.0	-	100.0	16

Chi-squared tests to examine the hypothesis that there is no difference between the distribution of responses to statements about the engineering profession and the teaching profession were not statistically significant.

How to Encourage Women to Study Technological Teaching

In answer to what should be done in order to attract women students to the CTEH, the following suggestions were offered:

1. Help in finding work after graduation, an undertaking which should be stressed in media announcements.
2. More scholarships should be made available during the study period.
3. Media announcements should stress that technological education is suited to women.
4. Student mothers should be helped to find suitable arrangements for their children.
5. Help in finding work during the study period.
6. Change educational emphases in the youngest of age brackets in order to encourage girls in the direction of technology.

CONCLUSIONS

As mentioned, 44% of the female students had a technological schooling background. This finding is of significance in that it suggests that girls should be encouraged to study technological subjects from an early age. Girls should also be employed in technological occupations in the framework of their military service.

One cannot ignore the fact that 44% of our respondents reported feeling disturbed by their being a minority in a male enclave. At the same time, 95% consider themselves to be good students. Engineering careers seem to "frighten" them more than technological teaching and, therefore, announcements by institutions in the media should emphasize their undertaking to help in finding work both during the study period and after graduation, and award grants and scholarships to students employed in teaching during their studies. In addition, the advantages of the "flexible" study program for married women should be stressed and student mothers should be helped to find a suitable arrangement for their children. Once the study conditions of women are improved, the women themselves can be relied upon to manage with the actual studies.

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THREE WOMEN'S EXPERIENCES IN CONSTRUCTION APPRENTICESHIPS

Katherine H. Downey

Ce document présente les conclusions d'une étude qualitative dans le cadre de laquelle on a analysé les expériences de trois Ontariennes faisant un apprentissage en construction et l'utilité de l'apprentissage autonome (McCombs et Whisler, 1989), tel qu'il se rapportait à l'acquisition, par les femmes, des connaissances du métier. On a effectué des entrevues en profondeur pour en apprendre davantage sur les expériences de ces trois femmes. Trois des plus intéressantes conclusions étaient que la formation professionnelle de ces femmes ne leur permettait habituellement pas d'accroître leurs compétences dans le métier. D'autre part, les femmes apprenaient fréquemment les cordes du métier dans un environnement de travail dominé par des hommes, souvent hostile. Enfin, les stratégies mises en oeuvre par les femmes pour acquérir les connaissances théoriques et aptitudes pratiques du métier semblaient soutenir la théorie de McCombs et Whisler (1989) de l'apprentissage autonome.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

THREE WOMEN'S EXPERIENCES IN CONSTRUCTION APPRENTICESHIPS

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ABSTRACT

This paper presents the findings from a qualitative study that explored three Ontario women's experiences in a construction apprenticeship and the usefulness of autonomous learning (McCombs and Whisler, 1989) as it related to the women's acquisition of trade knowledge. In-depth interviews were used to hear the women's apprenticeship experiences. Three of the more interesting findings were that the skill training the women received was habitually inadequate to enable them to increase their skill competence in the trade. Additionally, the women were frequently learning the skills of their trade in a male-dominated work environment that was often adverse. Finally, the strategies the women implemented when learning the theoretical knowledge and practical skills of the trade appeared to support McCombs and Whisler's (1989) theory of autonomous learning.

INTRODUCTION

Both a recent survey by the Ontario Ministry of Skills Development (MSD, 1989a) and an occupational analysis bulletin by Employment and Immigration Canada (1987), have projected a 25 percent increased demand for construction journeymen, especially in the piping trades. With the projections for construction trades and the consequent need for more women in these fields, women employed in skilled trade occupations require more attention, than previously received in the literature (Cherry, McIntyre, & Jaggernathsingh, 1991).

The two general purposes of this study were to hear the women's apprenticeship experiences and specifically how they learned about, and why they entered an apprenticeship and to explore the usefulness of McCombs and Whisler's (1989) theory of autonomous learning in relation to the women's acquisition of theoretical and practical trade knowledge.

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LITERATURE

A review of the literature suggests some themes for women employed or training in trade occupations. These women are likely to be mature adults making a career transition. Upon entry into the trade, these women were often faced with several negative experiences, including an initial decrease in self-confidence, co-worker hostility, and social isolation. However, positive factors such as monetary gains, a sense of accomplishment, and increased independence, tended to outweigh the negative issues.

Autonomous learning may be a useful framework to explore how women are able to learn the theoretical and practical components of their trade in an often adverse environment. Autonomous learning is a "developmental phenomenon that depends on the learner's development of the capabilities for self-regulation and self-control as well as personal beliefs of competence and the knowledge that learning can lead to the achievement of personal goals" (McCombs & Whisler, 1989, p. 278).

DATA COLLECTION METHODS

Apprenticeship training is the principal means of providing new journeymen for the piping trades. Recent data from the MSD show that, in January, 1991, approximately 38 women were apprentices in these trades distributed as follows: 25 in plumbing, 7 in refrigeration air-conditioning mechanic, and 6 in steamfitting. With the assistance of Ontario Women's Directorate and MSD personnel, as well as personal and third party contacts, the purposeful sampling yielded a population of 9 apprentices: 4 refrigeration air-conditioning mechanics, 2 plumbers, and 3 steamfitters. After initial contact, three key-informants in the third to fifth years of their apprenticeships, one each in plumbing (Jan), refrigeration air-conditioning mechanic (Donna), and steamfitting (Beth) trades participated in the study. The informed, consenting women were privately interviewed four times each from January to May, 1992. The audio-taped, unstructured interviews, of 45 to 60 minutes duration, incorporated Spradley's (1979) ethnographic interview strategies. The interviews were transcribed in full to prepared for the data analysis (see

Downey, 1991). Each statement made by the women was numerically coded in sequence and the location in the transcripts was recorded. For example, "3-26 p. 21" indicates the twenty-sixth statement made during the third interview, on page 21 of the transcript. The emphasis the women placed on a portion of speech was noted by underlining the appropriate section. In addition to the transcribed interview protocols, interview notes, field notes, reflective interview guides, and participant review formed the basis for the analysis and discussion of the data (Goetz & LeCompte, 1984).

RESULTS

The women in the present study were comparable with the composite depicted in the literature. The women averaged 30 years of age and were making a career transition into a trade occupation, after seven to nine years of employment in female dominated and male dominated occupations. They derived a sense of challenge and satisfaction associated with the tangible aspects of the trade. As Donna said, "I felt that I could take a great amount of pride in the fact that when I finished something it was running" (1-24 p. 14). Beth also reinforced the concepts of a sense of accomplishment and satisfaction when she stated, "It's the feeling that you've done something useful that you've worked hard to get where you're at. I guess a lot of it is actually intangible, just that you've accomplished something" (4-13 p. 7). In contrast to previous reporting, monetary gain was not the salient reason for the women's interest in their trade. Jan commented on the financial consequences of being an apprentice "I had a good job, a really good paying job" (1-13 p. 5).

The women learned about their apprenticeship through male acquaintances. Donna and Jan completed a pre-apprenticeship training program prior to entering their trade, and Beth worked as a general labourer for three years before indenturing as an apprentice.

The women's experiences in the present study concurred with previous reported disadvantages associated with employment in trade occupations including an initial

decrease in self-confidence and social isolation (Cherry, McIntyre & Jaggernathsingh, 1991). Donna recalled that "I didn't feel secure" (1-10 p. 8), and Jan stated, "I was really nervous, I didn't have a clue what to expect" (1-26 p. 8). Although Beth was employed as a general labourer before indenturing as an apprentice, she also expressed initial reservations, she stated, "the friend that got me the job...I didn't wanna let him out of my sight for the first three weeks" (1-62 p. 19).

Social isolation was evident in Donna and Jan's apprenticeship experiences. Donna said, "Socially I thought perhaps I would be able to fit in. But when you go out to coffee with the guys and they're ogling a waitress, you just don't fit in" (4-12 p. 14). When Donna reflected on the consequences of social isolation she said "I really needed a friend....Because I really was alone out there" (3-18 p. 14). Social isolation also appeared to be an element of Jan's work environment. Jan commented on the absence of social conversation, and said, "They just ignore you....I used to say it [good morning] all the time and no one would answer, so I stopped saying it" (4-33 p. 22). In contrast to Donna and Jan, Beth frequently commented on the social integration she experienced at work, "My favourite days at work are the one's where everyone's decided that we've done a good long hard stretch of work, let's have a few beers" (4-13 p. 7).

Previous reported disadvantages such as co-worker hostility was not supported in this study. The women commented on the acceptance they felt from other apprentices while in trade school. Donna stated that, "Although I did have things that I didn't like in there...I did feel a part of the group" (3-23 p. 18). Jan echoed Donna's feelings, "It's so nice going to school and everyone treats you nice" (4-13 p. 8). Beth also commented on the support she received from other apprentices "If it wasn't for the guys that I work with, that were also in school with me, I would have had a lot lower marks" (3-19 p. 7). Donna and Jan experienced hostility from male supervisors rather than male co-workers. Donna's reports suggest that one supervisor actively displayed his hostility toward her legitimacy in the trade, "My ex-boss made me cry....He was basically telling me that...I should be married and have a family....He's like what are you doing here?" (3-17 p. 13). Perhaps more obvious in Jan's experience was the differential work

assignments she received from male supervisors, "I have a lot to learn. And I haven't had the opportunity. They've been putting me on a lot of just gopher jobs" (1-53 p. 21). In contrast, Beth was adamant about her positive work experiences with male co-workers and supervisors, "From my foreman to my co-workers I would say maybe a curiosity for the first two weeks, and then I was just another worker. We got along fine, they were very supportive in every way that they could be" (2-50 p. 17).

Among the most interesting findings of the study concerns two themes that have not been reported elsewhere in the literature. The first issue was the lack of practical training Donna and Jan received during their apprenticeships. Donna worked with a mechanic for the first two weeks of her apprenticeship, then she was sent on her own to complete maintenance contracts, "Because I worked alone there was not apprenticeship in my mind. Like I was an apprentice on papers certainly, but you did not, you were not given any direction" (1-6 p. 7). Donna informed the union and the MSD about the lack of training she received to no avail, "Although there is a ratio set up by the Ministry Skills and Development it is rarely if ever enforced!...I have gone as far as I could have gone complaining about the lack of training and nobody cares" (1-4 p. 5). Jan commented on the lack of skill training she received, saying "They'll get me to clean all the time, and go for coffee all the time, or unload materials when it comes in off the truck or re-organize sheds...anything but hands on plumbing" (2-19 p. 10). Jan contacted the union several times to express her concern regarding work assignments and in the last six months of her apprenticeship was assigned plumbing tasks.

A second theme was the womens' perceptions that the group behaviour of some men focused on contemptuous comments about women. As Donna recalled, "When it came to jokes about women, and demeaning jokes about women, you know, you could smile about it and pretend you're laughing, but you're not really laughing" (4-13 p. 14). Jan stated, "The talk in the lunch room I can't imagine how, how these guys can talk this way about their wives....They talk about them like they're hookers" (4-23 p. 14). In Beth's words, "A lot of the talk that goes on at work could be described as, I don't know, locker room talk. A lot of it's about women, it could be considered derogatory

if you actually took them seriously" (4-11 p. 5). The present researcher was reluctant to consider this type of behaviour as examples of co-worker hostility primarily because these activities appeared to be directed toward women in general, and not the apprentices in particular. Rather, the actions of some males could be considered a barrier, but not necessarily discrimination toward the apprentices. The ramification of this type of barrier is that the women could be excluded from casual information and group acceptance in the work place. In contrast, the male-dominated academic learning environment was more favourable to the women and their experience in this environment was one of the more rewarding aspects of their apprenticeship.

McCombs and Whisler's (1989) theory of autonomous learning was used to explore the women's self-system process judgements when learning the theoretical and practical skills of their trade. The women's self-appraisals were used as a way of understanding what the women talked about and how they judged themselves to be competent when learning the trade. Although the women phrased the concept differently, they expressed an innate desire to determine their destiny. For example, when Donna recalled why she considered an apprenticeship, she said that, "The idea was born out of a sense of I did need something to do" (1-1 p. 3). Jan expressed her sense of destiny when she asserted, "Probably five years from now I'll be doing something very different again" (1-45 p. 17). Beth also reinforced the notion of controlling one's destiny, "I always have to be trying to go one step better or I really feel like I'm stagnating" (2-8 p. 3).

The women appeared to possess the pre-requisite developmental factors to be autonomous in the trade. Donna for example said, "I guess just the reality of, of becoming an adult....I'm five years older now, I'm a lot smarter than I used to be" (2-15 p. 7). The women also expressed confident self-system process judgement with respect to learning the theoretical and academic components of their trade, attributing their success to their study skills. Donna recalled, "I found refrigeration theory, very easy to understand" (3-4 p. 2), and ascribed her success to her dedication "I took it very seriously, plus I did a lot of studying" (3-4 p. 2). Reflecting on trade school, Beth's academic confidence was evident in her statement "As far as my marks went, I got

all A's. But there was a lot of studying" (3-18 p. 7). In summary the women's judgements of competence in the theoretical or academic components of the trade appeared to internally based on their cognitive abilities.

Focusing on the women's self-system process judgements concerning the practical aspects of the trade their responses demonstrated an internal and external focus. Internally the women spoke about relying on their mechanical intuition or aptitude to complete a new practical trade skill. Beth said, "Almost anytime you come across something new...you can just fall back on common sense" (1-79 p. 25). The women experienced difficulty in some specific skills, such as, the use of an oxyacetylene torch for Jan and Beth. The women felt that experience with the tools of the trade would increase their practical competence. However, the lack of practical training Donna and Jan received hindered their ability to demonstrate their skill competence. As Jan stated, "I think it [skill competence] would come with, just with practise. I don't get much practise at work" (4-31 p. 21). Donna recalled that, "I was not put on service calls...I was never really in the position that I would have to call upon many skills" (4-7 p. 7). In contrast, Beth appeared to be learning the practical components of the steamfitting trade in a positive environment. Not only was Beth comfortable to ask co-workers for assistance "You're not afraid to ask anyone for a hand because they're not gonna put me down for it" (1-7 p. 3), but her co-workers facilitated her acquisition of trade skills, "They'll volunteer to show you something when they've got a minute, and they're really helpful that way" (3-29 p. 10).

In summary, the women demonstrated an innate desire to determine their destiny and the necessary cognitive abilities to be autonomous learners in their trade. In the present study, self-system structures appeared to filter self-system processes in attempts to maintain or enhance self-esteem. However, self-system filters affected self-system processes within the affirmation of a positive environment. Within this context the women were able to be autonomous.

IMPLICATIONS OF THE STUDY

The results of this study extend findings in the literature that mature women tend to select trade occupations for the sense of accomplishment and challenge associated with tangible work. In contrast to previous reports, monetary gain was not the salient reason for the women's interest in a trade occupations.

The lack of training issue documented in this study warrants action by the MSD. The MSD could take an active role to ensure that apprentices receive the practical training in their trade by monitoring and enforcing the apprentice to journeymen ratio outlined in the specific trade regulations (e.g., MSD, 1989b). Secondly, the MSD could convert the current time-based criteria of apprenticeship training to a modular competency-based structure.

Finally, in reference to McCombs and Whisler's (1989) theory of autonomous learning, the present study indicated that when women received external support for their interest in a construction apprenticeship then they were more likely to complete the necessary training. External support could be provided to women by pairing women on the work site and sensitizing male co-workers to the potentially isolating effect their conversations and actions may have on women sharing the work environment.

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GENDER AND COMPUTING: CHANGES OVER TIME IN SCOTLAND

Alan Durndell, Helen Watt, Pauline Lightbody

On a demandé à vingt-sept étudiantes, ayant assisté à un atelier universitaire d'informatique mis sur pied pour les femmes, de remplir un questionnaire d'évaluation de leur usage de l'ordinateur et de leurs attitudes face au traitement informatique. On leur a demandé de remplir ce même questionnaire une deuxième fois deux ou trois ans plus tard. Les résultats ont révélé que malgré le fait que de nombreuses réponses n'aient pas changé, et plus particulièrement celles qui ont trait au sentiment que l'informatique est une activité masculine, on observe un désir de plus en plus marqué, avec l'âge, de travailler avec les ordinateurs ou d'étudier l'informatique. Nous traitons de la question en nous fondant sur de récents travaux britanniques.

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GENDER AND COMPUTING: CHANGES OVER TIME IN SCOTLAND

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ABSTRACT

27 schoolgirls who attended a university computer workshop for girls were given a questionnaire assessing their use of and attitudes towards computing. They were given the same questionnaire one or two years after. The results indicated that whilst many of the responses were consistent over time, particularly in supporting the impression of computing being a male oriented activity, there was a significant shift with increased age against expressing the desire to either work with computers or to study computing. This is discussed with respect to other recent British work.

INTRODUCTION

In Britain a small proportion of students of computing are female (about 13% in the Universities according to UCCA, 1992). The organisation Women into Computing (WiC) has tried to address this situation, and amongst other strategies schoolgirl only computing workshops have been put on at Universities. Watt (1991a) described one of the first large scale exercises of this sort which began in 1988 and has been running annually since then. Amongst the techniques used were to have female outside speakers and female staff members as successful role models, to use user friendly Apple Mac systems and to pay attention to the atmosphere of the visits.

These dayschool workshops have been very popular, and have been considerably over subscribed leading to rationing of the places available to schools. Various issues have to be faced in organising such events (cf Watt, 1991b) such as deciding what age group to target, how many male specialists to involve and what software to use. However, the underlying rationale for organising these events is that they might play some role in increasing the attraction of computing for girls, leading more of them to study computing

in higher education.

Whether it is reasonable to expect that a one day experience of this sort will effect the girls long term behaviour is an open question, but on the other hand why put effort into such initiatives if they do not have some permanent result? There has therefore been interest in assessing any effect of these sessions, mainly directed at measuring attitudes towards computing. Watt (1991c) presented data from her 1989 sessions where she had measured attitudes towards computing in a questionaire given out at the beginning of the workshop and again at the end of it. The data clearly showed a significant shift towards more positive views of computing, apparently brought about by the workshop. Wilkinson (1992) provided similar data from a 4 day residential course for 6th form girls, whilst Newton (1991), in an attempt to obtain a more long term view, followed up schoolgirls from a number of other workshop sessions. In this case attitudes were remeasured 4 months later (using the approach of Todman and File, 1990). Newton found that there was still a significant effect after this time lag, with the schoolgirl's attitudes shifted in a more positive direction towards computers than as measured before their dayschool.

That the effect was still persisting after 4 months was an interesting finding, and raises the question of what would be found if schoolgirl samples could be tracked for a year or two. This was therefore investigated utilising a small sample from Watt's work.

METHOD

Outline

Schoolgirls who had attended Watt's June 1989 workshop session and had filled in a questionnaire, were given the same questionnaire in summer 1991, thus 2 years later. Different schoolgirls who had attended Watt's 1990 workshop session, and had filled in a questionnaire both immediately before the 1990 session and immediately after the 1990 session were given the same 1990 questionnaire in summer 1991, thus 1 year later. The responses 1 or 2 years on were compared to the original responses at the time of the workshop session attended.

Subjects

The sample consisted of 16 schoolgirls from 4 schools who had attended the 1989 workshop session, and 11 different schoolgirls from 2 of the same schools who had attended the 1990 session. The girls were of an average age of 14 when they attended the workshop session, in all cases being at the end of their 3rd secondary year in the Scottish system. All were still at school on retesting in 1991.

Materials

Those girls who had attended the workshop in 1989 were presented with the same questionnaire that had been used in 1989. This included a variety of questions covering experience of computers, attitudes to computers and responses to the workshop. Rather than improve or refine this questionnaire, the same format was used to facilitate comparison between the two sets of responses. Those who had attended the workshop in 1990 were presented with the 1990 version of the questionnaire that they had filled in before and after their workshop session. The 1990 questionnaire was a refinement on the 1989 questionnaire, although many of the items remained the same.

Procedure

A female researcher contacted the schools via the teacher who had organised the school's visits to the workshop sessions. Several visits were then made to each school to sort out the practicalities of tracing the pupils. The questionnaires were filled out in the school situation.

RESULTS

(1) *The sample of 1989 workshop girls retested in 1991:*

In general the answers given in 1991 were very similar to 1989. For example 7 out of the 16 answered yes to the question of whether there was a computer in your house in both 1989 and 1991.

Particular interest centred on 6 attitude statements that were presented on a 5 point scale ranging from 1 (definitely agree) through to 5 (definitely disagree). 4 of these

produced responses that were not significantly different in 1989 and 1991:

a) *Do you think that computing is just for boys?*
This achieved a unanimous answer on both occasions of 5.

b) *Do you think that computing is mathematical?*
The average score for 1989 was 3.3, for 1991 3.1.

c) *Do you think that people working in computing need to be able to communicate well?*
The average score for 1989 was 2.9 and for 1991 was 2.7.

d) *Do you think that people working in computing spend all of their time working at their machine?*
The average score for both 1989 and 1991 was 3.9.

Two statements produced significantly different responses in 1989 and 1991, using a related t test:

a) *Would you like a job in which computing is a major part?*
The average score for 1989 was 2.6, and for 1991 was 3.2 (related t=1.987, p two tailed <0.05)

b) *Would you like to study computing at University?*
The average score for 1989 was 2.7, for 1991 3.8 (related t=3.922, p two tailed <0.001)

(2) *The sample of 1990 workshop girls retested in 1991:*

Again the responses in general were the same over time, although the one girl who attended a computer club in 1990 had given up by 1991! Reported use of computers outside school, rated on a 5 point scale from 1 (never) to 5 (daily), reduced from an average of 2.7 in 1990 to 2.2 in 1991 (related t =2.159, 2 tailed p<0.05), whilst the question of whether they read computer magazines on a 1 (never) to 5 (daily) scale produced a mean response of 1.4 in 1990 and 1.3 in 1991.

The 6 attitude statements were used in the same form as for the 1989 sample and data was available for 3 occasions,- before the 1990 workshop, immediately after the 1990 workshop and on retest in 1991:

4 statements again produced non significant results:

a) *Do you think that computing is just for boys?*
On all occasions this statement produced a unanimous 5, definitely not.

b) *Do you think that computing is mathematical?*
The average score for 1990 pre workshop was 2.5, 1990 post workshop was 2.8, and 1991 retest was 2.7

c) *Do you think that people working in computing need to be able to communicate well?*
The average score for 1990 pre workshop was 2.2, 1990 post workshop was 1.8, and 1991 retest was 2.6

d) *Do you think that people working in computing spend all of their time working at their machine?*
The average score for 1990 pre workshop was 3.9, 1990 post workshop was 3.8, and 1991 retest was 4.5

Two statements again produced significantly different responses between 1990 pre workshop and 1991 retest, using a related t test:

a) *Would you like a job in which computing is a major part?*
The average score for 1990 pre workshop was 2.6, 1990 post workshop was 2.8, and 1991 retest was 3.1 (pre workshop vs 1991 retest related $t=2.244$, p two tailed <0.05; other pairings non significant)

b) *Would you like to study computing at University?*
The average score for 1990 pre workshop was 3.1, 1990 post workshop was 2.8, and 1991 retest was 3.8 (pre workshop 1990 vs 1991 retest related $t=2.93$, p two tailed <0.01; post workshop 1990 vs 1991 related $t=3.3$, 2 tailed $p<0.01$, other pairing non significant)

The scores for the two statements to produce significant results are shown below in more detail:

Table 1: Percentage of 1989 sample respondents using each point on the scale for the statement:
Would you like a job in which computing is a major part?

	Definitely				Definitely not
	1	2	3	4	5
In 1989	0	50	37.5	12.5	0
In 1991	0	31.4	25	37.5	6.2

Table 2: Percentage of 1990 sample respondents using each point on the scale for the statement:
Would you like a job in which computing is a major part?

	Definitely				Definitely not
	1	2	3	4	5
In 1990 pre workshop	8.3	33.7	41.7	16.7	0
In 1991	0	16.7	50	25	8.3

Table 3: Percentage of 1989 sample respondents using each point on the scale for the statement:
Would you like to study computing at University?

	Definitely				Definitely not
	1	2	3	4	5
In 1989	0	31.2	56.2	12.5	0
In 1991	0	18.7	18.7	25	37.5

Table 4: Percentage of 1990 sample respondents using each point on the scale for the statement:
Would you like to study computing at University?

	Definitely				Definitely not
	1	2	3	4	5
In 1990 pre workshop	8	25	50	25	0
In 1991	0	0	33.3	41.7	25

DISCUSSION

In spite of the relatively small sample the results were fairly clear. The general picture painted was all too familiar and fitted in with other research (cf Durndell, 1990, 1991). Whilst the girls unanimously did not think that computers were just for boys, much of the information that they gave (not all reported above) pointed in that direction. No girls went to computer clubs and hardly any ever read computer magazines.

The two key results, strengthened by the consistency of most of the other responses given over time, were the significant shift with increasing age against expressed desire to work in a job with a large computer element, and the significant shift against desire to study computing at university. Both features were found in both samples, and are disappointing in as much as the girls attending the workshops might well have been thought to be amongst those more likely to have been interested in computing. What seems to have happened is that the developmental trends outlined by Glissov (1991) have overwhelmed any specific effect of the workshops. The tables showing more details of these responses indicate that this situation was not the result of one or two large individual shifts of opinion distorting the general picture, but of a more general shift of opinion. These results appear to contradict those of Newton (1991), but may be compatible as the results obtained here might be about expressed intentions to be involved with computers, whilst Newton was addressing attitudes towards computers.

Attitudes could remain positive whilst intentions (and behaviour?) could indicate avoidance.

Other recent research in Scotland confirms the impression of little overall change over time vis a vis gender and computing. Durndell (1991) reported on a comparison between 1986 and 1989 intake samples of recent school leavers who had just entered university. They had all opted to study biological sciences or business studies, and were qualified to study computing but had chosen not to. This study has now been extended to include a 1992 intake sample (Durndell, 1993, in press). The results show a clear significant male advantage maintained over females in knowledge about IT (as measured by a short quiz), and continued significantly greater reported male home use and ownership of computers. The negative and similar views of both genders about working with computers were also maintained.

There are many unanswered questions raised by this small scale study, a number of which would require a much larger investment of research to resolve: Would the girls have shifted even more against computing if they had not visited a workshop? Were the more positive views expressed at the workshops an artifact of being asked whilst at the workshop? (Though cf Newton, 1991). Did one or two girls retain a positive shift over time? (It was the case that not all the sample shifted in a negative direction over time, and if just one out of twenty were attracted into computing this might make the workshops worthwhile). Are the older girls more sophisticated/realistic about the world of study and work? Finally specific school effects are no doubt very important.

None the less, in spite of the caveats, the results were clearcut. The girls sampled might have been thought to be more computer oriented than girls in general, yet the results still painted a picture of adolescent computing tending away from being a female activity. In particular the expressed views of the sample towards studying computing or working with computers shifted in a negative direction over one and two years. Whilst these findings are somewhat disappointing for those running the workshops, it was perhaps too much to hope for a large scale effect from a one day experience, as other more longterm influences like gender role expectations are very powerful. It is also possible that a small number of participants, perhaps too small for the present study to detect, might be shifted in a positive direction.

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GENDER AND MATHEMATICS IN VOCATIONAL TRAINING AND EDUCATION

Kirsten Gonbaeu Hansen

Au cours des quelques dernières décennies, on a constaté une érosion du traditionalisme en matière d'activités féminines ou masculines. Plus particulièrement, les femmes se sont mises à explorer les domaines traditionnellement masculins. En dépit de cela, certains bastions mâles demeurent; ces obstacles sont parfois insurmontables. L'activité créative des mathématiques est l'un de ces bastions. On accepte plus ou moins que les jeunes filles et les femmes puissent être «bonnes en math», mais leurs accomplissements sont considérés comme étant le résultat d'un dur travail plutôt que d'un éventuel don. Du moins, c'est ce qu'on a découvert dans le cadre d'une étude sur la formation professionnelle et l'éducation. Ce point de vue est tenu par les jeunes hommes et la plupart des adolescentes, malgré leurs expériences en classe. Il semblerait que la créativité en tant que telle traverse une transformation au niveau de sa signification culturelle, qu'elle change de sexe. Il est possible que ce phénomène soit dû au fait que les valeurs traditionnellement masculines, comme la rationalité, s'automatisent et sont, par conséquent, de moins en moins appréciables en tant que qualifications personnelles.

Le document de recherche est disponible auprès de l'auteure.

GENDER AND MATHEMATICS IN VOCATIONAL TRAINING AND EDUCATION

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During the last few decades there has been an erosion of the traditional barriers betwen of activities for females and males. Especially women have explored the traditional male areas. In spite of this fact, we still have male bastions (fortifications?); barriers that can't or only with great personal expenses be broken. One of these bastions is creative mathematical activity. It is more or less accepted, that girls and women can be "good at math", but their achievements are interpretated as a result of hard work, rather than a result of giftedness. At least this was found in a study in vocational training and education. This interpretation is held up by young men and by most young women in spite of their actual experiences in class. It seems that creativity as such is going through a change of cultural meaning, is changing sex. This could be because a traditional male value like rationality is becoming automized, and therefore less valuable as a personal qualification.

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GENDER AND ASSESSMENT OF STUDENTS IN PHYSICS

Elizabeth Hegarty-Hazel, Peter Logan et Patricia Gallagher

Les recherches sur l'apprentissage des filles et des garçons ont démontré que l'évaluation est un facteur clé dans l'établissement des approches à l'apprentissage des étudiantes et des étudiants. L'évaluation joue un rôle crucial en ce qui a trait aux intérêts et à la motivation des étudiantes et étudiants dans une matière donnée, à la qualité de leur apprentissage, leur volonté et leur aptitude à poursuivre d'autres études et à envisager une carrière dans le domaine. Ces questions sont importantes du point de vue équité, ainsi que des points de vue apprentissage et évaluation. La recherche, en grande partie conduite au palier secondaire, suggère que dans le domaine des sciences et de la technologie, les choix multiples, les questions décontextualisées et quantitatives abrégées n'ont rien d'attirant pour les jeunes femmes et peuvent même les désavantager dans les évaluations.

Ce document fait état de nos recherches sur l'évaluation des étudiantes et étudiants dans les sciences physiques à l'université - un des principaux domaines où le sous-recrutement et le faible taux de rétention des femmes demeurent un problème. La recherche implique une analyse, par sexe, des questions d'évaluation et de comparaison des performances des étudiantes et étudiants en première année de physique. Les résultats ont révélé que le type de question et le contexte dans lequel la question est posée ont tendance à avantager les garçons. On a relevé quelques différences entre les performances des hommes et celles des femmes dans des questions d'évaluation de différents types. On parlera de stratégies en vue de modifier les évaluations dans les programmes de sciences physiques, de façon à utiliser des approches mieux adaptées aux deux sexes.

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GENDER AND ASSESSMENT OF STUDENTS IN PHYSICS

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ABSTRACT

Research on student learning has shown that assessment is a key factor in determining students' approaches to learning. Assessment plays a crucial role in students' interest and motivation in a subject, the quality of their learning, their willingness and ability to pursue further studies in the field and to consider careers in the area. These are issues of concern from an equity perspective as well as from the learning and assessment perspectives. Research, mostly conducted at secondary school level, suggests that in areas of science and technology, multiple choice, short quantitative and decontextualized questions are unattractive to young women and may disadvantage them in assessments.

In this paper, we report on some research into assessment of students in the physical sciences at university level - one of the main areas where under-recruitment and lack of retention of women remain a problem. The research involved analysis of assessment questions and comparisons of students' performance in first year physics by gender. Results suggested that the question type and the context within which the questions were set were likely to favour male students. There were some differences in the performance of women and men on assessment questions of different types. Strategies will be discussed for changing assessments in the physical sciences to use more gender balanced approaches.

INTRODUCTION

Strong arguments have been made by Murphy (1988) that an equitable assessment of knowledge assumes that question cues are understood in the same way by all students, the task perceived by students matches the assessor's perception, failure on a task reflects a lack of the knowledge being tested and that the form of expression selected is appropriate to skills/knowledge being tested and unproblematic for all students. These assumptions are not always valid since students do not necessarily have similar out of school experiences, and therefore have differences in learning styles. Rennie and Parker (1991) synthesised research findings at high school level with reference to the mode of testing, the item format and the item context, and argued that assessment procedures are invalid if they fail to elicit knowledge from students who in fact possess the knowledge - for assessment to satisfy both construct and content validity, a variety of forms of written and oral communication is required to enable

students to demonstrate their knowledge of subject matter and problem solving abilities. Research on students' world views and students' construction of knowledge like research on gender, emphasises the importance of context.

There have been few studies on the role of language background in science assessment at university level. Logan and Bailey (1989) showed that students of non-English speaking background (NESB) have trouble with some of the non-technical words in science. Other issues may be that if the students translate questions into their own language there is likely to be language and cultural interference; if qualitative assessment questions ask for alternatives to be presented and discussed this may be to the disadvantage of students from some traditional cultures. Cassels and Johnstone (1984) found that the effect of language on student performance in science operated at a subtle level where, for example, positive measures of magnitude were more uniformly understood than negative ones.

Scheuneman (1987) clarified two major sources of assessment bias - the characteristics of examinees which manifest group differences and the characteristics of tests or test items which have different effects or create different demands between groups. For the British 16+ exams, Harding (1979) found sex differences with boys performing better on multiple choice questions, and girls performing better on essay type questions. Scheuneman and Gerritz (1990) concluded that women and minorities are not disadvantaged by the MCQ format itself but by a combination of item features which produce an accumulation of small effects, each of which is related to the weaknesses of one of the groups being compared or the strengths of the other. They used the phrase 'test-wiseness' to denote students' appreciation of what is expected in a test or item and found test-wiseness to be a function of race (but it seems that in other settings it could be a function of gender or class). Hegarty-Hazel, Gallagher and Logan (1992) reported that traditional university physics assessments may be biased in favour of male students, if their preference for short quantitative questions or MCQ is mirrored by performance.

We conclude that the range, form and context of assessment questions are each potentially important for female and male students, of English speaking and non-English speaking background in the physical sciences.

THE PROJECT SETTING AND THE STUDENTS

The project was carried out with all Physical Science students enrolled in First Year Physics. There were 128 students, with 48 (38%) female and 34 (36%) were students with a Non English Speaking Background (NESB). For this study NESB students were defined as those who were born in a non English speaking country, had undertaken at least primary education there, and who speak a language other than English for more than 25% of the time at home. There were four groups for comparison - male and female students with English Speaking Background (ESB) and NESB male and female students. For this paper the four comparisons of special interest are - NESB/ESB, male ESB/male NESB, female ESB/female NESB, male NESB/female NESB.

There were two dimensions to the project: (1) diagnostic tests administered during students' first week at university. These tests included mathematics readiness, language, science concepts physics readiness tests as well as approaches to learning and attitudes to different science subjects. Some paired test questions were used in these tests to investigate the effect of context, diagrams, negative statements and concepts, use of Plain English, and use of everyday rather than textbook situations. (2) various forms of continuous assessment (40%) administered during the semester and a final examination (60%). To provide variety of assessment Multiple Choice Questions were added to the traditional class tests and the final examination. Qualitative questions, including mini-essays were added to the class tests, the laboratory examination and the final examination. The laboratory report was modified to require full discussion of results.

While results of the diagnostic tests can only be briefly discussed in the following section, results of the regular continuous assessment and final examination are reported in some detail.

STUDENT RESULTS ON DIFFERENT FORMS OF QUESTIONS

On the diagnostic test, all students performed better with questions using Plain English, use of negatives disadvantaged all students and diagrams helped all students. Somewhat surprisingly, students performed better at questions with 'no context' questions and could answer questions on basic principles but could not apply them to everyday life. A number of questions were reset in context but this resulted in poorer performances rather than better,

probably because the students were familiar with the abstract question types from their school studies. Many students could not go from the abstract to the concrete. This suggests students had only a superficial understanding of the principles.

CONTENT ANALYSIS OF ASSESSMENT ITEMS

Content analysis carried out on all the items used in the continuous assessment and the final examination for Physics 1 in 1991 and 1992 are shown in Table 1 (percentages are based on the number of questions). The categories used were as follows (for more detail, see Hegarty-Hazel, Gallagher and Logan (1992). 1. Type: A question was coded as quantitative if the required answer was numeric or algebraic. If the required answer was verbal, the question was coded as qualitative. 2. Structure: This concerned the format of the questions, which were assigned to one of the following four categories: the multiple choice question (MCQ), the short definite question, the short flexible question and the report. 3. Context: This concerned whether the question was set in a context, and if so whether it was masculine, feminine, or gender neutral.

TABLE 1: CONTENT ANALYSIS OF ASSESSMENT ITEMS

	Class Tests		Prac Exam		Final Exam		Total	
	1991	1992	1991	1992	1991	1992	1991	1992
	%	%	%	%	%	%	%	%
Type								
Quantitative	94	70	40	33	85	57	78	62
Qualitative	6	32	60	67	15	43	22	38
Structure								
MCQ	0	47	0	0	3	31	2	36
Short definite	97	32	40	33	85	49	84	40
Short flexible	3	21	40	50	12	20	11	22
Report	0	0	20	17	0	0	3	2
Context								
No context	49	62	20	33	62	59	52	57
Masculine	19	6	20	33	22	10	17	10
Feminine	4	2	0	0	0	4	1	2
Neutral	29	30	60	33	16	27	30	31

TABLE 2 - STUDENT PERFORMANCE ON ASSESSMENT OF DIFFERENT TYPES, STRUCTURES AND CONTEXTS

	Total %	Women %	Men %	ESB %	NESB %
Type					
Quantitative	48	42	51	48	42
Qualitative	54	51	56	56	48
Structure					
MCQ	58	52	61	59	56
Short definite	50	45	53	50	50
Short flexible	53	50	54	54	48
Context					
No context	53	49	56	55	46
Context	39	33	43	39	34

TABLE 3 - GENDER AND LANGUAGE BACKGROUND

	Women ESB %	Women NESB%	Men ESB %	Men NESB %
Type				
Quantitative	54	46	56	55
Qualitative	64	48	58	55
Structure				
MCQ	57	55	65	62
Short definite	56	50	56	58
Short flexible	62	44	55	55
Context				
No context	61	49	59	57
Context	43	38	47	48

STUDENT PERFORMANCE

Table 2 shows students' overall performance on question of different types structure and context with comparisons are made by gender and by language background (ESB and NESB) and Table 3 shows further comparisons for those students who had completed physics in the same matriculation examination the previous year (using t tests at the 5% level).

The women (ESB only) performed significantly better on the qualitative questions, most of which were of the short flexible type. The lowest performance for the four groups was from women of NESB who were identified as a group at risk in this physics course. The men (both ESB and NESB) performed significantly better on the multiple choice questions. All groups performed better on the decontextualised questions than those set in an everyday context.

Since there were rather few questions set in a 'masculine' context and almost none in a 'feminine' context, we were unable to pursue further the effects of context - superficially, it appeared that all groups performed better on questions set in a 'masculine' rather than gender-neutral context.

The nature of students' difficulties with the contextualized questions may be illustrated in a pair of questions which were set in different parts of the diagnostic test at the start of the university year:

No context provided

When an object falls through air, the force of air resistance, F, is proportional to the radius of the object, a, and its velocity, v. Therefore this can be expressed as (if k is a constant)

A. $F = \frac{ka}{v}$ B. $F = \frac{kv}{a}$ C. $F = kav$ D. $F = \frac{k}{av}$

Gender neutral context provided

In investigating pollution we need to know the length of time the pollutant remains in the atmosphere. It is found that the force of air resistance on a piece of grit polluting the atmosphere is proportional to the radius of the grit, r, and the speed at which it is falling, v. Hence this force, F, can be expressed as (where k is a constant)

A. $F = \frac{kr}{v}$ B. $F = \frac{kv}{r}$ C. $F = krv$ D. $F = \frac{k}{rv}$

Rather than all students performing better when the question was set in an relevant everday context or women responding better with context, as might have been expected from some gender literature, all students actually performed significantly worse, if anything women more so. We interpreted this as an indication that for students who had recently completed physics at matriculation level, the first question looked like a standard physics question but the second did not. Some students treated both questions similarly and were able to apply an algorithmic approach to answering both.

Table 4 shows numbers of students and their grades using the new type of assessment package introduced in 1992. The grades are H (high distinction), D (distinction), C (credit), P (pass), F (fail). The table also shows predictions of 1992 results based on 1991 assessment package. It is seen that fewer students obtained a distinction on the new pattern because the

new pattern required a greater breadth of understanding to obtain high marks. Seven students with an adequate knowledge to pass the course when a range of assessment types was used, would have failed if the older, highly quantitative pattern had been used.

TABLE 4 STUDENT GRADES WITH DIFFERENT ASSESSMENT PATTERNS

		H	D	C	P	F
1992	Assessment Pattern	7	9	23	53	22
1991	Assessment Pattern	7	13	21	44	29

DISCUSSION AND IMPLICATIONS FOR TEACHERS

In the past, quantitative questions had been used extensively for assessment in the course described here as it was felt that those were the types of problems a physics graduate would encounter. It had not been recognized that students might be able to perform well on quantitative questions without a good qualitative understanding of the issues. There was probably an implicit understanding by staff that students who could perform well at the quantitative questions would also perform well at qualitative questions and at the MCQs. However we found students who did very well on quantitative questions but could not explain the concept correctly. Others could explain concepts but were not able to apply them to quantitative problems.

Our findings on language background were that although the male NESB students performed less well than the male ESB students in the diagnostic language items on arrival at university, their performance in the course overall was equivalent to that of the male ESB students. However, female NESB students performed poorly in the diagnostic language items, and poorly throughout the semester including on the qualitative questions (where the female ESB students excelled). This resulted in similar performance overall of male-NESB, male-ESB and female-ESB, but female NESB students performed 10% below the other groups overall. We believe that NESB students, especially the women, should be strongly encouraged to utilise the university English language support facilities for assistance with their language difficulties. More should be done to help with language and communication within physics.

Findings for different question formats suggested that diagrams should be used wherever possible. Negative statements and concepts should be avoided. Plain English should be used wherever possible.

Questions in context and transferring from abstract-to-concrete produced difficulties for all students. We do not suggest that this important link be abandoned but rather that questions in context should be introduced gradually and that students should be provided with examples. We expect that quantitative questions should still play an important part but believe that they should be supplemented by short flexible questions or essays which ask students to explain and discuss concepts and their applications; to explain the working involved in a quantitative question and encourage students to link the abstract to the concrete. Male students may perform slightly better on MCQs than female students. However some of the research on student learning links the use of MCQs with students taking a surface approach to their study. We believe that MCQs, if used at all, should be used to differentiate concepts rather than for numerical problems.

Overall, our research findings, like much of the hortatory literature, has suggested that a range of assessment types should be used.

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WOMEN IN MATHEMATICS AND PHYSICS: INHIBITORS AND ENHANCERS*

Carol Hollenshead and Cinda-Sue Davis

Pour que la réserve américaine de mathématiciennes et mathématiciens et de physiciennes et physiciens puisse être élargie, il est essentiel que les universités de recherche tiennent un rôle majeur dans toute initiative visant à l'élargir. Toutefois, peu d'études tiennent compte de l'expérience des étudiantes et étudiants en mathématiques et en physique de premier et deuxième cycles des principales universités de recherche. Par ailleurs, on ne sait pas grand chose des facteurs qui ont un impact particulier sur l'expérience des étudiantes dans ces domaines. Afin de modifier la situation, l'University of Michigan a conduit trois études, avec le soutien de la Alfred P. Sloan Foundation. Chacune de ces études explore les perceptions des étudiantes et étudiants et les facteurs qui ont contribué à la persistance des étudiantes et étudiants ou à la perdition des effectifs.

WOMEN IN MATHEMATICS AND PHYSICS: INHIBITORS AND ENHANCERS*

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Abstract: If the pool of U.S. mathematicians and physicists is to be enlarged, research universities must play a central role. Yet few studies have examined the experience of mathematics and physics undergraduate and graduate students in major research universities. Moreover, little is known about factors which have a particular effect on the experience of women students in these fields. In order to address this knowledge gap, three studies were conducted at the University of Michigan with support from the Alfred P. Sloan Foundation. Each of these studies explored students' perceptions and the factors which contributed to student persistence or attrition.

The Honors Mathematics Experience

The first study surveyed students enrolled in first semester Honors mathematics courses during the Fall Terms of 1987 or 1988. These students represent some of the best prepared incoming students and are a potential pool of mathematics and science concentrators. Because of this, their experiences, especially during the early formative semesters, might help to explain some of the documented gender differences that are so apparent by the end of the undergraduate and into the graduate years. Previous social and academic forces already restricted the number of female students in our pool; fewer than 30% of the Honors mathematics students were women despite the fact that over 40% of the incoming General Honors students were female.

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* *Based on findings of a study conducted with our colleagues Susan Frazier-Kouassi, Oksana Malanchuk, Patricia Shure, David Burkam, Patricia Gurin, Donald Lewis, Patricia Soellner-Younce, and Homer Neal. For a copy of the full research report contact the Center for the Education of Women, 330 E. Liberty, Ann Arbor, MI 48104-2289, Phone: 313-998-7080.*

The study documents an exceedingly high "dropout" rate in terms of continuing Honors mathematics enrollments. Only 15% of both the male and female students enrolled in the program completed the Honors mathematics sequence. But there is a striking difference between the male and female students who dropped out. The majority of the women (58%) dropped out of the Honors mathematics sequence and elected no further mathematics courses; whereas the majority of men (54%) dropped out of Honors mathematics but continued in non-Honors mathematics. The marked difference in the proportion of men versus women who continued in mathematics after dropping the Honors sequence is greater than might have been predicted on the basis of their mathematics experiences. Gender differences in experience and choice revealed by the study appear to be based on differences in perception, not in ability.

Students offer various reasons for dropping out of the honors sequence with the majority citing the material as unnecessary for their studies. Certain motivational differences for dropping out of Honors mathematics were also apparent. While more than half of all students felt the material to be unnecessary, the male students cited two additional external factors with greater frequency: heavy course load and "outside factors." The female students cited a lower level of interest in the subject matter.

The overall attrition rate may be partially explained by the ultimate concentration decisions (less than half of all students went on to major in the sciences). Female science concentrators were more likely to be in the life sciences (requiring less mathematics), while male science concentrators were more likely to be in mathematics or the physical sciences.

Almost no gender-based differences in students' self-described classroom behaviors emerged within the Honors mathematics students, the exceptions being the

greater likelihood of women to admit to feeling unable to solve a mathematics problem and their lesser likelihood to be tutoring others in mathematics.

When asked if gender in any way affects treatment of students in their department of concentration, over twice as many women students responded with "yes"--33% in comparison to only 16% of the men. When asked if gender has affected the student personally, 26% of the women responded "yes," but only 8% of the men. Of those students, male or female, who claimed the existence of gender bias, the overwhelming majority felt that the bias was against women. Women were also more sensitive to environmental influences, rating a cooperative setting more beneficial and a competitive setting more detrimental than did their male peers.

With regard to post college plans, comparable proportions of men and women were planning to enter graduate school in non-mathematics/non-physics areas (approximately 60%). Three times more men (18%) than women (5%) planned to attend graduate school in mathematics or physics, whereas women indicated a greater likelihood that they would teach or work in a non-research/industry setting.

The Mathematics/Physics Major Experience

The second study surveyed students who graduated with majors in mathematics and physics in 1990. While this study revealed few gender differences, those which emerged were consistent with those identified in the Honors study. Even among those who completed these majors, women were less likely to find encouragement in their departments, less likely to say professors took a special interest in them, and had slightly lower self confidence than the men.

There were also marked gender differences in choice of subspecialty within mathematics. More females than males chose teaching (25% vs. 7%) while most of the

males were in pure and applied mathematics (62% vs. 46%). Almost equal numbers were in actuarial mathematics (about 30%).

We asked the graduating seniors to identify the most influential courses they had taken at the University of Michigan--both positively and negatively--and what effect they had had on their enthusiasm for majoring in their field. The most striking finding is that the women cited the instruction of the class as the most influential factor in contributing to their knowledge and understanding, regardless of whether they thought that class had made the greatest or the least contribution. If they liked a course, it was because it had an excellent instructor and was well-taught (67%). If they disliked a course, it was because it was poorly taught or the professor was difficult to understand (75%). It is noteworthy that poor teaching is the largest indicator for both men and women for turning students off and sometimes for their dropping out of mathematics and physics classes.

The Mathematics and Physics Honors Programs offer an incentive for good students to take rigorous and challenging courses. Yet more men than women remember being informed of the honors classes (53% vs. 38%). Among those who were informed, 52% of the men said someone encouraged them to take honors, but only 10% of the women said so. No woman felt she was discouraged, but fully 90% of the women felt they were neither encouraged nor discouraged to take honors classes in sharp contrast to 33% of the men. This is a very similar result to that found among accelerated mathematics students.

Similarly, almost three-quarters of the men told us that a professor had taken a special interest in them as a student, less than half of the women did so. Among those who felt they were encouraged--and almost half of the women did--most said a professor had counseled them about course work. Not only is there a perception of lack of

encouragement among women in the Mathematics and Physics Departments, but more active discouragement was reported by the women as well. When asked about whether any professors had had a particularly discouraging effect on the student's interest in mathematics or physics. Over half (54%) of the women said yes, compared to 38% of the men. The form this discouragement took varied. Most often it was just poor teaching, but women also noted a particular type of discouragement--discouraging comments--made by faculty.

Students were also asked directly if they noted any differences in the departments in the treatment of students by gender. About a quarter of both males and females said they had noticed that gender affected the treatment of students in their department. The women, more than the men, believed that this took the form of bias against women, 86% vs. 39%.

With respect to the immediate post-college plans of the mathematics/physics majors the female graduates were more likely to be taking a paid position (62% vs. 39%) and the males going to graduate school (27% vs. 48%). This is probably an outcome of their subspecialties with women more likely to be teachers and actuaries. But it also highlights a finding in the literature that women, regardless of ability, are less likely to follow the direct path to graduate school.

There were no significant gender differences in other areas of the students' experiences. About half the students entered the university with the intention of majoring in something other than mathematics, physics and engineering, but revised their plans and finished as mathematics, physics or engineering majors.

The experiences and attitudes of these mathematics and physics majors reveal a strong emphasis on the importance of good teaching and the need for faculty

encouragement for women students. Clearly, this lack of encouragement does not result from the fact that the women are poor students. Indeed, not only do they do nearly as well as the men, but some even suggested program changes because they deemed the requirements too lenient.

The results of our surveys reveal that good teaching, faculty encouragement, and providing appropriate challenges are important factors in creating learning environments which foster the self-confidence and achievement of women.

Graduate Women in Mathematics and Physics

The third study involved qualitative analysis of data from two focus groups of women graduate students in mathematics and physics. Several themes emerged from the analysis that were again consistent with the literature and the two other surveys. Among them, encouragement from faculty and parents played a key role in the women's undergraduate experiences and their decisions to persist in their studies.

During the discussion, participants described their undergraduate experiences with many similar comments about the important individuals and events that encouraged them to pursue their studies and careers in mathematics and physics. In addition, some shared stories of negative experiences or discouraging events which somehow empowered them to continue in pursuit of their present educational goal.

Encouragements: The women identified the encouragement as coming from certain sources: parents, professors, other teachers and staff members.

> "[During college] in the Math department, my faculty members knew who I was, they took a real interest in what I was doing whereas in [another department] I was one of many and I think that all my professors knew was my name and that was it."

> "When I started college I wanted to be a physics major. I had a wonderful AP physics class in high school with an enthusiastic young teacher .... I did well and liked it. But when I got to college, I hated physics lab and had a bad experience

> in my first class. My assigned freshman advisor...was leaving and she suggested that I ask my math professor to be my advisor. He was also chair of the math department and usually doesn't advise, but he said he'd be my advisor, [and said] 'and then you'll be a math major, right?' He then asked me to be in his honors program seminar."

Influential Persons: The women who talked about influential persons or mentors in their life were talking about more than just faculty-student interactions. These interactions were purposeful and supportive to the women and they went beyond helping strictly with academic matters. The importance of building personal relationships with faculty is evident in the women's comments. Their recollections hold favorable, enriching memories that had obvious effects on the woman's decision to go to graduate school.

> "One professor took me under his wing. When I was having a hard time he'd encourage me. And even now he just sent me a card to let me know he's thinking of me and wishing me well, and that was really important to have someone behind me encouraging me to go on. Just letting me know I had potential even when I ran into roadblocks like not doing well on a test, ... that was okay, I really had potential to do this. That was probably the most beneficial thing."

> "I had one female faculty member who really encouraged me... She was very descriptive, made things seem fun and wasn't into all this competition you feel in a lot of classes."

> "Even though there were more women there [in a social science department], I found it harder to be a woman [there] than in math and I would credit that to one woman in the math department. She's not a faculty member, she's an instructor; because she's not a researcher, she's interested in education, in women, in students.

Competition: All but one woman in the focus groups emphasized the rigors and demands of a competitive environment. Their comments also reflected feelings that competition is alienating, unfeminine, uncomfortable and often distressing. One woman, who came to the United States for her graduate training commented,

"The system of education in the U.S. is much different from my home country. Here everyone is so competitive. There we study in groups, share everything, don't care about grades. Here, it's different."

"Sometimes it seems that the system of grad school is based on male attitudes of competition -- sink or swim. The alpha courses in math, the first year courses, ended up being very competitive. Some people just rise to the competition and the kind of person who rises to the competition tends to be male."

"I really did well last year, objectively. I rose to the competition last year, and I did want to beat out these guys who always were trying to figure out who got the highest grade. But I didn't like it and I was embarrassed that I did what I did, that I did feel competitive. But I felt sick and I never told my exam scores to anyone. Whereas they [men] seem to get a kick out of this whole thing."

In summary, the experiences and perceptions of the three groups of undergraduate and graduate students seem more similar than dissimilar. Academic performace and ability are clearly not the factors the served to limit women's persistence and achievement. Student perceptions of science and mathematics, of the educational environment, and of their own abilities, play critical roles at various points along the educational pipeline. Encouragement, whether by faculty, family or peers appears to be a critical link in the chain that helps build and maintain the self-confidence needed to continue along the desired path to a higher degree in mathematics or science.

Recommendations:

Carefully designed research is needed to increase our knowledge of the causes of student attrition and to develop effective means of increasing women students' success and persistence. Particular needs include: (1) longitudinal studies, (2) national studies, (3) observational studies, and (4) studies of women who have left the sciences.

Although there is a need for research to steer the course of future programs, we cannot afford to wait for results before beginning to implement institutional change. Steps departments and colleges should take to produce such change include:

1. Systematically assess the present situation, analyzing comparative data on numbers and rank of women faculty, numbers of women students at each level, levels of available funding for women faculty and students, and retention, etc.

2. Systematically engage in departmental self-study to determine: which strategies succeed and which fail; which teachers are most successful in working with women students and why they are successful; what are faculty attitudes; why do women leave the program; what elements of the department climate are most supportive and which are not supportive.

3. Analyze the structure and content of advising to broaden the role of the advisor to that of advocate; train advisors to emphasize expectations of competence.

4. Formalize regular means of providing feedback and encouragement to students (e.g., faculty-student conferences, written progress updates, formal mentoring).

5. Use more experienced faculty to teach introductory courses; use outstanding faculty as master teachers. Restructure the faculty reward system to provide better incentives for teaching undergraduates.

6. Establish more collaborative classroom environments and grading practices; provide students with opportunities for team study.

7. Establish regular mechanisms to sensitize faculty to issues of gender and pedagogy and the means of eliminating gender bias in the classroom.

8. Create a safe environment and conduct regular educational sessions on harassment.

Ultimately, increasing the numbers and success of women scientists and mathematicians depends upon the actions of academic departments and colleges. Each college and university can begin programs to revise the curriculum and strengthen the interaction and communication between students and faculty; programs which increase the numbers of women students and faculty; programs which provide an academic atmosphere in which women are expected to succeed and in which sufficient numbers of successful women are visible at all levels; and to revise the curriculum so that all students are engaged in thoughtful intellectual work.

REFLECTING RESEARCH SUBJECTIVITY IN THE ROOM OF SOCIOLOGY AND ENGINEERING

Anette Kolmos

Un des objectifs du colloque international GASAT est de trouver des chercheuses et chercheurs et des praticiennes et praticiens de tous les secteurs : sciences, sociologie, génie, psychologie, etc. Regrouper des membres de toutes ces professions et disciplines comporte des avantages et des inconvénients. Les avantages reposent sur le fait qu'on a recours à un groupe interdisciplinaire pour analyser les problèmes de GASAT et sur l'aptitude à élaborer diverses stratégies pour résoudre ces problèmes. Pour ce qui est des problèmes, ils surgissent habituellement dès que des professionnelles et professionnels aux antécédents divers décident de travailler ensemble. De tels problèmes existent aussi dans les colloques GASAT, mais je ne parlerai ici que du lien entre la sociologie et le génie représentant le conflit traditionnel entre l'observateur et l'observé, qui s'estime «dénudé» et touché au niveau de son identité.

Dans ce document je décrit la façon dont mon attitude personnelle à l'égard de du génie et des femmes s'est développée au cours d'une étude effectuée auprès d'élèves-ingénieures et élèves-ingénieurs. Pour parvenir à des résultats valables dans une collaboration interdisciplinaire, j'estime que la seule stratégie possible est un dialogue franc et constructif sur les aspects cognitifs et affectifs du processus et des résultats de l'étude.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

REFLECTING RESEARCH SUBJECTIVITY IN THE ROOM OF SOCIOLOGY AND ENGINEERING

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ABSTRACT

One of the characteristics of GASAT is to find researchers and practitioners from all areas: Science, sociology, engineering, psychology, etc. To gather all these different professions and disciplines implies both advantages and disadvantages. Advantages in having an interdisciplinary focus in analyzing GASAT problems and ability to develop multistrategies for problemsolving. However, disadvantages always arise the moment professionals with different knowledge background are working together. These problems also exist in GASAT, but I will only deal with the relation between sociology and engineering which has been the traditional conflict between an observer and the observed part feeling uncovered and touched on an identity level.

My intention with this paper is to describe how my personal attitude to engineering and women developed during a study of women and men engineering students. To get any further in an interdisciplinary collaboration, I think the only strategy will be an open and constructive dialogue based on reflection concerning both cognitive and affective aspects of the research process and results.

SETTING THE SCENE

Since the beginning of the early 80s, you will find many sociological investigations of women in the technical and scientific fields (Kvande 1984, Due Billing and Bruvik Hansen 1984, Ballyn 1986, Kolmos 1989, Carter and Kirkup 1989, Durndell 1990, Overdijk 1990, Vedelsby 1991). For all these investigations you will find different theoretical frameworks, different problem focuses and different methods, however, common to all these investigations is the use of sociological methods and partly a focus on women as actors, their experiences, attitudes and values.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

In this paper I will only reflect my own use of sociological methods in my study of women engineering students at Aalborg University carried out 1985-89 (Kolmos 1989, Kolmos 1991). In this investigation I have used both questionnaires, observations and interviews in order to catch women and men engineering students' attitude to the engineering education, gender and technological development.

My investigation came up with different results depending on the methods I have used. In the questionnaire part my conclusions were that there were no significant differences between men's and women's attitude to the engineering education, nor the contents or the educational practice; although there is a tendency that women rather than men prefer a project-organized study (Kolmos 1989, Kolmos 1990). The investigation came up with similar result concerning the question of gender and technology. However, the results from the interviewing part gave a much more diverse picture of both women's and men's conceptual understanding and attitude to the importance of gender identities, strategies and relations in the engineering education. According to the use of different methods, these different results may not be surprising, however, it was a surprise to me, because I expected to find declared gender differences.

The fact that I did not find obvious gender differences in my research and that my results differ from what, on a personal and political level, I "wished" women in engineering to be (more critical of technology) led me into a deeper personal reflection of my own research methods. This paper contains only parts of these reflections focused on the research subjectivity and outline recommendations for sociologists researching in the technological and scientific fields.

THE PROBLEM FOCUS

My very first formulation of the problem was to investigate the role of gender in a male-dominated area and whether women should have another approach to technology. This formulation seems neutral and open, however, beyond that formulation my theoretical framework and my political and personal attitude focussed on the contradiction between women's values and the values in engineering. The focus was primarily on women and men as actors. Such focus was very common at the time in the middle of the 80s and was in Denmark built upon Ulrike Prokop's (Prokop 1978) theories on women's values and productive forces. This attitude also characterized the work recruiting women into science and technology based on the hope that women would change the direction of the technological development.

This first formulation of the problem was not only based on attitudes and a theoretical framework from the 70s, but also on the current Scandinavian investigations which were focussing on women's problem-coping in a male-dominated area. Very much of the theoretical development in these investigations was concentrated on analyzing women's coping strategies which indeed seemed relevant according to the design of the investigation. Later I realized that the problem when using the concepts of coping strategies was that beyond the concept of coping strategies was the attitude that it would not be possible to get any room to femininity in a male-dominated area - women would always oppress their own femininity.

MY FIRST CRISIS AND THE THEORETICAL BASIS

In my research design I had decided to follow a group of women from their first year to the 6th semester, and I had decided to develop my theoretical work parallel to my empirical investigation. Looking in the rear-view mirror, this was a very clever but very difficult decision. On the one hand it gave the

opportunity of developing the theoretical framework in a reflecting dialogue with the empirical work, on the other hand the analyzing process was difficult to control because theory cannot be the only analyzing instrument.

My first crisis arises during the very first interviews with women engineering students entering the first year programme. They seemed to have no problems - at all. At all levels in my interviews - both questions concerning their action, their attitude, their choices I found no direct or indirect recognition of having problems. OK, I thought, this interview took place at the beginning of the first year - their experience will change their attitude. However, at the end of the first year I could notice no fundamental change.

Meanwhile I had started to reflect on my theoretical basis and especially the theoretical concepts of masculinity and femininity (Kolmos and Holmfeld 1986). For this purpose I was inspired by Skogemann (1984) who had the theoretical inspiration from Jung and had developed four levels for interpretation of gender: the biological, archetypical, social and individual. Later I combined this with Harding (1986) who outlines three asyncronic levels at which gender has to be interpreted: the symbolic, social structural and individual. No matter what the different levels are called, the important aspect in this thinking is that the interaction between these levels will always be asyncronic, and that gender must be interpreted at each separate level. This means that what may be a typical woman activity in one part of the world may be a very man-dominated part in another part of the world - or what may be interpreted as masculinity and femininity at a symbolic level may not find its logical parallel at a social structural level.

In the relation between theory and empiricism such a theoretical framework does not outline any content analysis, but stresses that gender has to be analyzed on each level. This obviously throws any investigation of gender in relief by pointing out at which level gender has been and has not been

investigated.

Such a theoretical framework does not give very much help to the content analysis, and in my case I chose to use theory as a reference and relief which leaves the analysis of the empirical investigation to an interpretation at a common sense level. A common sense level interpretation, I put in between a theoretical interpretation on the one hand and a purely empirical interpretation on its own terms on the other hand. But even though using theory and other investigations as reference and relief to my empirical analysis, you will have an open room for interpretation of the collected data (both questionnaires and interviews) on its own terms and by that the research subjectivity will play a visible role.

THE RESEARCH SUBJECTIVITY

My basic assumption is that researchers project their own ideas and conception into the purpose, the planning, the choices, the process and the result of the research work. Irrespective of it's size, we do it and we must be very much aware of it. This fact does not only concern sociology, but it is a very common criterion for researching in all scientific fields - and it has been on the feminist agenda to reflect objectivity and subjectivity and to rethink and overcome the false reductionary contradiction between a declared scientific objectivity and a hidden subjectivity.

For several reasons it is a very hard process to analyze ones own research subjectivity, and I will just mention a few obstacles. The basic idea is that knowledge and identity are closely tangled into each other in a research process. It may be very hard to separate the attitude part of identity from research knowledge, and I am not arguing that we are going to make any separation at all. On the contrary, we must use this relation at a much more conscious level by emphasizing our considerations beyond every choice in the

research process. That means in the starting phase to draw up the objectives and the problems, in the phase of choosing theory and methods, in the phase of analyzing the empirical data, and in phase of conclusion.

However, the very combined relation between identity and research knowledge also concerns the question of how subjectivity influences the analysis of one's own research subjectivity - or in other words how to get on to a more conscious level of research?

Returning to my own experience from the first interviews on women's experience, I started to reflect on my theoretical basis concerning gender analysis, and I started to reflect how my own attitudes influenced my choices. The core in these reflections was my attitude to women, femininity and masculinity and technical science. At that time I had a twofold attitude to these areas: on the one hand I had started this investigation because of my former interest in mathematics and physics which my counsellor in school told me not to study, because it was for men and because I was very good at writing essays. On the other hand I had some kind of idea that men students at the engineering study were "technically narrow-minded" without a social understanding, and that it would be very difficult to have feminine values in an engineering study. To interview women and men at the engineering study at the same time being a teacher at the engineering faculty changed that attitude and turned it into an interest for the construction of technical science. So both at an affective level I changed my attitude and my feeling that it could be impossible to be a woman in engineering, and at a cognitive level I learned aspects of technical scientific subjects and by that I became able to understand a technical fascination. The core is also that I learned that engineering is not just one culture, engineering covers many different cultures and many different approaches to technology.

However, even though I learned some technical science, I felt in the

analyzing phase of my research project that I needed more technical knowledge to get to a deep level of understanding. Understanding is an important element in the cognitive research process and goes far ahead compared to registration and explanation. The understanding level in this research project goes to the roots of values marking choices in individual life.

To set up this criterion for understanding is very ambitious, and it will imply that in this case the researcher is an educated engineer as well as a sociologist for achieving this level of understanding. This is not realistic. On the other hand it would not be any better if it was a researcher with a background in engineering without fundamental knowledge of sociology. That would just give other kinds of problems, e.g. that it would be an understanding description without the outsiders' reflection which I still find fundamental.

However, irrespective of the researcher's background it is important to reflect her identity and in this case especially her attitude to the researched area as one of the criteria in the validity of the investigation, and this becomes even more important when the investigation concerns actors, attitudes and values. One of the most obvious methods to analyze this is to keep a researcher's diary of the researching process and to analyze this as a natural part of the validity aspect of the research project.

RINGING THE CURTAIN DOWN

Focus has changed in the Scandinavian research from a focus on actors to a focus on structures, e.g. organizational structures and cultures (Due Billing and Alvesson 1989, Kvande and Rasmussen 1990). This change is mainly caused by political and strategical considerations, because a focus on actors and attitudes very often lays the foundation stone for a GASAT strategy of recruiting more women and changing science and technology on women's shoulders. On the other hand, focusing on structures points out the structural

barriers of a GASAT strategy and moves the focus away from the single woman and man.

Of course it is very difficult to separate actor and social structures - they are very closely combined and it may not be worth pointing out structural barriers without pointing out the actors' willingness to be part of a change. However, the social structures and the gender ideology create the individual actors and are so to say a very important element in our gender knowledge. I have no doubt about that the reason why I did not find obvious gender differences in my research concerning women and men engineering students is to be found at the structural level, because my university practises a problem and group-based project work during the entire engineering education.

Returning to Harding (1986) gender must be analyzed at all levels: symbolic, structural and individual. In GASAT we have mostly been at the individual level and we must take a more offensive part at the other levels, although this will not solve the question on research subjectivity.

Obviously, research subjectivity will play a more visible role in qualitative analyses of individuals' attitudes and values. However, subjectivity exists all the time and will arise in every choice during the entire process. Back in 87 in Ann Arbor, the concept of dynamic objectivity created by Fox Keller (1985) was on the agenda - and why do we not start by ourselves?

When I received the comments from the organising committee who had reviewed my first abstract and classified this as an accept with reservation because of the missing link to gender, I became even more convinced that this may be a very fundamental issue in GASAT, because research results are used for strategies. You may reflect the research process with a declared gender aspect or not - I do not care any longer, I just think it must be a basic scientific criterion in order to get a more honest science.

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SATISFACTION WITH THE GRADUATE EXPERIENCE: STUDENT PERCEPTIONS OF THE ACADEMIC CLIMATE

Jean Denby Manis

De nouveaux résultats de recherche provenant d'un sondage effectué auprès d'étudiantes et étudiants de deuxième cycle de l'University of Michigan ont permis de reconnaître les éléments du monde académique qui favorisent une expérience positive et ceux qui donnent naissance à des sentiments d'aliénation et/ou de mécontentement. On s'est particulièrement intéressé à ces phénomènes tels qu'ils affectent les femmes, les étudiantes et étudiants dans les domaines non traditionnels et les étudiantes et étudiants de couleur. Nous comparons les réponses des femmes étudiant les sciences physiques, les mathématiques et le génie à celles des femmes d'autres domaines pour établir que les femmes qui ont choisi les sciences sont confrontées à des défis et conditions différents des autres femmes. Les sujets couverts incluent le mentorat, le harcèlement sexuel, les autres formes de discrimination et les délais ou les difficultés auxquels ont dû faire face les 1 009 répondantes.

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SATISFACTION WITH THE GRADUATE EXPERIENCE: STUDENT PERCEPTIONS OF THE ACADEMIC CLIMATE

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ABSTRACT

New research findings from a survey of graduate students at The University of Michigan identify those features of the academic climate that promote a positive experience, and those that lead to feelings of alienation and/or dissatisfaction. Special attention is given to gauging the climate for women, for non-traditional students, and for students of color. Responses of women in the physical sciences, mathematics, and engineering are compared with those of women in other fields, to ascertain whether the women in science face different conditions than other women. Topics covered include mentoring, sexual harassment, other forms of discriminatory or derogatory treatment, and sources of delay or difficulty experienced by the 1,009 respondents.

The Project on the Graduate Experience, which was carried out at The University of Michigan by the Center for the Education of Women in collaboration with the Horace H. Rackham School of Graduate Studies, was designed to identify those features of the academic climate which promote a positive graduate experience, as well as those which contribute to feelings of alienation and/or dissatisfaction. A second objective was to gauge the climate for women in graduate education at the University of Michigan and evaluate how it may differ from the climate for men. Nationally, women earn over half (52%) of the bachelor degrees, but only 36% of the doctorates. Recruiting more women to graduate programs is important; providing a supportive environment for degree completion and professional development is equally critical. This latter set of issues is the focus of this study. A special effort was made to assess the presence of "micro-inequities," those subtle behaviors which devalue women and can pervade an environment practically undetected.

An extensive questionnaire was mailed to a random sample of graduate students at the University of Michigan in the spring of 1991. In addition to the random sample, all students of color and all women students in mathematics, engineering and the physical sciences were included, in order to obtain adequate data on these populations that tend to be

underrepresented at U-M and other institutions. The data were later weighted to generate results representative of a true random sample of the university's graduate student population. A total of 1,009 students returned the survey, which represents a response rate of 42%.

OVERALL ACADEMIC SATISFACTION

When asked about satisfaction with their overall academic experience at U-M, about 60% of respondents indicated that they were moderately or very satisfied with their experience and few expressed strong dissatisfaction. Nearly half of the respondents were moderately or very satisfied with the quality of instruction in lectures and with the research guidance they had experienced. However, only 33% were moderately or very satisfied with the academic advising they had received, and only 15% were moderately or very satisfied with U-M's "institutional concern for students." The highest levels of satisfaction were associated with various specific resources--library, computer, recreational and health facilities.

Overall levels of satisfaction were not significantly related to gender, ethnicity or academic division (e.g., social sciences or humanities). But non-citizens were more satisfied than citizens, and length of time in program was negatively related to satisfaction. Among women, those in Ph.D. programs were more satisfied than those in master's programs.

STUDENT PERCEPTIONS OF THEIR ENVIRONMENT

To assess students' perceptions of their environment, respondents were given a list of 45 adjectives and asked to check those that fit their image of U-M. While the order of endorsement followed roughly the same pattern for men and women, there were several gender differences. Women were more likely to describe U-M as bureaucratic, stressful, political, elitist, biased, masculine, empirical, rejecting and caring. Men were more likely than women to endorse the terms liberal, accommodating, open and realistic.

Factor analyses of the adjective descriptions revealed five underlying dimensions, which we labeled as follows: (1) PERSONAL, which included eight descriptive terms--warm, caring, welcoming, supportive, friendly, flexible, adaptable, and cooperative; (2) ACCEPTING, which included six terms--accepting, tolerant, accommodating, liberal, aware, and open; (3) EXCITING, which included four terms--exciting, inspiring, stimulating, and creative; (4) DEMANDING, which included six terms--demanding, intense, competitive, stressful, intellectually rigorous, and ambitious; and (5) ALIENATING, which included five terms--cold, lonely, remote, impersonal, and rejecting.

The level of endorsement of these perceptions of the environment can be shown simply by the percentage of students who had checked at least one of the descriptive terms in each set:

Perception of Environment: School/Dept.	Describing U-M	Describing R's
Personal	35.6%	62.8%
Accepting	52.8%	64.0%
Exciting	54.9%	51.8%
Demanding	88.4%	85.9%
Alienating	52.0%	34.3%

The most commonly held perception of the U-M is that related to academic rigor, and this is true for the departmental descriptions as well. Slightly more than half of the students describe the U-M as accepting and as exciting. A smaller proportion--36%--view U-M as personally warm and supportive, while roughly half of them find it alienating. Students see their department or school as more personally supportive, more accepting, and less alienating than the U-M as a whole, but even so a third of them reflect a sense of alienation.

These perceptions of the environment proved to be the most important predictors of overall academic satisfaction: Students whose descriptions indicated a sense of alienation expressed lower levels of satisfaction, and those who viewed the University as accepting or demanding expressed higher levels of satisfaction. *Women were more likely to see*

the U-M as alienating, and less likely to describe it as accepting, than were men.

ATTITUDES ABOUT COMPETITION

Studies of U-M undergraduates have shown that women tend to dislike an intensely competitive classroom--such as the atmosphere characteristic of many early science and math classes (Manis et al, 1989). Apparently graduate students share this reaction, as shown by their endorsement of this statement: "I would like more cooperative or interactive approaches to learning at U-M." Overall, 82% of the respondents agreed with this statement. Women were more likely than men to agree strongly (46% vs. 33%); nevertheless, 77% of the men agreed, either strongly or somewhat, with this view. A second statement--"The competitive atmosphere at U-M contributes to feelings of alienation and isolation"--elicited 60% agreement from women, compared to 45% of the men.

Students volunteered many comments about the negative effects of the competitive climate. Central to their criticism was their view of the environment as pitting the individual against all others, rather than fostering a sense of community and shared endeavor.

SATISFACTION WITH ACADEMIC ADVISING AND MENTORING

Student comments about the adequacy and quality of academic advising and mentoring at U-M made clear that this is a crucial aspect of their graduate experience. When asked how satisfied they were with the extent of mentoring they had received thus far, only 42% said that they were moderately or very satisfied, and 29% said that they were moderately or very *dissatisfied*. However, of those who regarded their current advisor as a mentor, 62% reported moderate or high satisfaction with the relationship. Women were less satisfied than men with the mentoring they had received. (Among students in Ph.D. programs, the gender difference was not significant; among master's students, women were markedly less satisfied than men.) In open-ended responses about disappointing aspects of their U-M experience, the factor mentioned most frequently by women was a lack of adequate advising or mentoring; 26% cited this problem, compared to 16% of men.

Presented with a list of 23 problems that might cause significant delay or difficulty for students, 32% of the women and 24% of the men in Ph.D. programs checked lack of mentorship or guidance as a problem they had faced; among master's students, 37% of the women and 21% of the men did so. Many students said that the mentoring (and teaching) functions suffered as a result of the pressure on faculty to do research. Many of the respondents who felt that adequate mentoring could be found stressed that it was up to the student to take the initiative in establishing contacts and relationships.

SEXUAL HARASSMENT AND DEROGATORY TREATMENT

As might be expected, a much greater percentage of women than men reported sexual harassment. Nearly a fifth of the women reported that they had experienced sexual teasing, jokes or innuendos from faculty members, and a like percent reported hearing male faculty members make offensive comments about the bodies or sexuality of women students, staff or faculty. Respondents experienced higher levels of such behavior from other students; nearly 40% experienced sexual teasing, etc., and 36% reported hearing other students make offensive comments about women faculty, staff, or students. Other types of unwelcome sexual behavior were reported less commonly from both faculty and other students. Sexually suggestive looks or gestures from faculty were reported by 9% of the female respondents, deliberate touching, crowding or pinching by 6% and pressure for sexual favors, 1.5%.

The following illustrative comments were in response to an open-ended question on this issue. "A senior faculty member....often touches my neck or face as if he had an absolute right to do this...." "The professor I T.A.'d for used to touch me a lot (a pat on the back, a squeeze on the arm)...in front of the class (mostly male), which I felt really undermined my authority with them." "Male faculty members – 3 faculty members, in my experience . . . make sexually suggestive comments and innuendos, none in relation to specific people, but sexual innuendos nonetheless. This activity makes one hesitate to meet them in office hours."

In response to the question, "Have you ever been treated in such a way that you felt ridiculed or humiliated?", 34% of the women and 20% of the men reported that they had experienced such treatment. Respondents' open-ended descriptions of the behaviors they considered derogatory or discriminatory revealed several types of interactions: (a) Incidents in which the respondent felt personally belittled or embarrassed, or treated harshly or unfairly criticized; (b) examples involving cultural, ethnic, or racial misunderstandings or stereotypes; (c) situations in which respondent's contributions or opinions were ignored, devalued, or not taken seriously; (d) examples involving disagreement with or rejection of respondent's theoretical or ideological views; (e) instances where the respondent was unfairly denied needed academic or professional support (such as letters of reference, or jobs, or financial support). Classroom settings and consultations with professors were mentioned most frequently as the situations in which such behavior occurred.

The most frequently perceived bases of such behavior were gender; interests, values or goals; race or ethnicity; and ideological or theoretical views. Close to half of the students of color reported that they had experienced at least some discriminatory or derogatory treatment that they interpreted as a reaction to their race or ethnic group. Only a fourth of students of color indicated that they had *not* experienced *any* discriminatory or derogatory treatment, compared to 41% of Caucasian students.

ATTITUDES OF NON-TRADITIONAL STUDENTS

In terms of overall satisfaction with their academic experiences and mentoring, there were no significant differences between the one-fifth of the students who had children and those who did not. When asked about problems involving dependent care, parents saw U-M as less helpful than did other students. Women–whether parents or not–rated U-M significantly less helpful, flexible and concerned than did men. Among student parents, women reported significantly greater difficulty with coordinating their school and work schedules with their children's needs. Women also reported a higher level of stress when responding to statements about the pressures associated with combining their student role

with other aspects of life, such as work, family or outside activities. Women were also more likely to mention problems associated with commuting to campus.

As one woman commented, "In order to have my baby, nurture my family, and stay sane I've cut myself off quite a distance from my department. I already feel in disfavor for having a baby .... Considering that most graduate students are probably in the 25-35 age range, prime time for having kids, the university needs to become more family-oriented."

WOMEN IN PHYSICAL SCIENCES, MATH, AND ENGINEERING

Because of continuing concerns about attrition among women in the physical sciences, mathematics, and engineering, we included all women in these fields (Division 2) in the sample of students who received questionnaires. We then compared women across academic divisions, to see whether those in Division 2 differed from others in their perceptions of the environment, level of academic satisfaction, or other sources of satisfaction or dissatisfaction. We also compared men and women within Division 2, to see whether there were greater gender differences in this area than among our respondents as a whole.

In general, for men or women, academic division was not significantly related to overall academic satisfaction, to satisfaction with mentoring, or to the environmental perceptions held by students. Indeed, in comparisons of Ph.D. women across divisions on a variety of items, women in Divisions 1 (biological and health sciences) and 2 frequently appeared to give somewhat more positive responses than did those in other divisions.

There are several factors that may be related to the relatively positive outlook of women in Division 2: First, students in Division 2, men or women, are the least likely to mention financial problems or constraints as sources of delay or difficulty. Second, they tend to complete their degrees in less time than students in other areas, and years in program is negatively related to overall academic satisfaction. Third, they are less reliant on positions as teaching assistants, and hence less likely to have experienced the unwanted sexual attentions--from students or faculty--to which teaching assistants are apparently more likely

to be exposed. Fourth, they are least apt to have children, and hence least likely to face whatever problems or stresses accompany parental status.

Women in Division 2 were marginally more likely than those in other divisions to cite the difficulty of required course work as a source of difficulty or delay (p=.0629). However, they were less likely to describe their departments as demanding. And they were less likely than other women to say that they "almost always" felt stimulated and excited by their studies. They also appeared to hold more doubts about staying in school--33%, compared to 49% of Ph.D. women generally, indicated that they almost always felt confident that they would complete their degree. (Speculation about possible factors underlying this greater uncertainty about finishing might suggest the following: lack of confidence in their abilities, possibly related to a lack of positive feedback and encouragement from faculty and/or students; dislike for the departmental or pedagogical atmosphere; or uncertainty about pursuing a career in science, among others.)

Two other comparisons point to pedagogical issues that may affect students' reactions to coursework in Division 2. Among female Ph.D. students, women in Division 2 were less likely than those in other areas to say that they "almost always" enjoyed their classes. And they were less likely to say that they expressed their views in class; compared to women in other divisions, more women in Division 2 said that they "almost never" expressed their views in class, and fewer said that they "almost always" did so. Men in Division 2 also were less likely than other men to say that they expressed their views in class, suggesting that students play a more passive role in Division 2 classes.

One other difference by division among women in Ph.D. programs contradicts a common stereotype: Women in Divisions 1 and 2 were significantly less likely to perceive their academic environment as masculine than were women in Divisions 3, 4, or 5. Overall, those who perceived the environment as masculine were more likely to express a sense of alienation. Masculinity may be a more salient dimension for women in the social sciences or humanities because of the issues they are interested in and because the subject matter they deal with is inherently more deeply engendered.

With respect to gender differences, comparisons between women and men in Division 2 revealed no greater differences in views or experiences than was true for men and women generally, across all divisions.

CONCLUSIONS AND RECOMMENDATIONS

Clearly, more attention should be given to the provision of adequate academic advising, particularly in the student's early years. Having a departmental system of appointing advisors is not sufficient, if those advisors are not knowledgeable about relevant policies and procedures, or do not have time to consult with students, or hold derogatory views about students based on characteristics such as gender or ethnicity. Faculty should regard mentoring as part of their prime responsibilities, and faculty and administrators should provide leadership in establishing a welcoming atmosphere within their school or department, and in setting norms for their students concerning appropriate professional behavior.

Student preference for more cooperative approaches in the classroom should be taken more seriously; providing challenges for students, and eliciting intense effort, does not depend on maintaining an aggressively competitive atmosphere.

Greater attention to the problems of students who have family responsibilities, who commute to class, or who must maintain jobs to support themselves, would address student perceptions of the U-M as unhelpful and indifferent. Child care facilities, greater flexibility in office hours and class scheduling, and access to parking are issues of importance to nontraditional students.

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FEMALE SCIENCE RANKHOLDERS IN POST-GRADUATE COURSES AND CAREER CHOICES: AN INDIAN EXPERIENCE

D' B. Regina Papa

Ce document traite de l'effectif croissant des filles dans les programmes de sciences de niveau supérieur des universités indiennes et de la proportion beaucoup plus faible de choix de carrière à leur disposition.

Les résultats de cette étude indiquent que dans un pays comme l'Inde, où le chômage et le sous-emploi sont chose courante, les choix de carrière des femmes dont le niveau d'éducation est plus élevé sont plus souvent affectés par des facteurs sociaux et institutionnels que par des idéologies des sexes.

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FEMALE SCIENCE RANKHOLDERS IN POST-GRADUATE COURSES AND CAREER CHOICES: AN INDIAN EXPERIENCE

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ABSTRACT

This paper discusses the increasing enrolment of girls in tertiary science courses in Indian Universities and the much lower proportion of their career choices and absorption.

The results indicate that in a country like India where unemployment and underemployment are rampant with their attendant maladies, career choices of women, with a higher level of education, are more likely to be affected by social and institutional determinants than by gender ideologies.

INTRODUCTION

Science and Technology in a developing country like India cannot be a mere pursuit of knowledge driven by intellectual curiosity. It should rather serve as a problem solving mechanism, the biggest problem confronting almost all sections of people in the country being unemployment and under employment. One expects that scientific and technological growth would consequently generate more career choices in related areas.

Enrolment of female students in S & T courses in Indian Universities has increased from 27.5% in 1979-80 to 32.2% in 1987-88. They constitute 31.3% of the total University students enrolled in various science courses. At the Post-Graduate level,, the increase has been from 27.1% in 1979-80 to 32.7% in 1987-88 (UGC, 1988:184-186). Though the percentage of female enrolment has been consistently going up at all levels of science education, women are found to lag behind

in career absorption.

The employment position of male and female scientists ranging from under-graduate Diploma holders to Doctorates is given in Table 1, which evidences the low female proportion in employment.

Table 1: Employed and Self employed Scientists by level of Qualification and Sex, 1981

Level	Male	Female	Total
Doctorates	13834	1536 (9.99%)	15370
Post Graduates	141956	25293 (15.12%)	167249
Graduates	411883	63243 (13.31%)	475126
Others (Under Graduate Diploma)	14817	1518 (9.29%)	16335
Total	582490	91590 (13.58%)	674080

(Female proportion to the total is given in brakets).
Source: **Science and Technology, Pocket Data Book**, Govt. of India, Department of Science and Technology, 1991, p.37.

The present study concerns the impact of academic success in the case of female rank holders in Post-Graduate Science Courses on their career achievement.

METHOD

Names and addresses of female achievers for the academic years 1989 and 1990 were collected from four Universities in South India. A minimum of 2 years of interval was allowed to give the students time to settle in life after their post-graduation.

Care was exercised in the selection of the four Universities from different developmental backgrounds (rural-1; semi-urban-1; urban-1; Women's University-1).

There were 34 rank holders in all and census method was adopted. Questionnaires were posted to all 34 rank holders and 21 respondents returned them for analysis. 6 did not respond and 7 were not found in the addresses sent.

The questionnaire requested informations on family environment, reasons for selecting the particular science course, career choices envisaged at the entry point and their present career status. The questionnaire also carried items on personality in terms of extra-curricular interests and talents, enrolment in Associations, and regular reading of science magazines.

Analysis of the influence of gender ideologies on their career choices was carried out in two groups:'in-job' group and 'not-in-job' group using two types of questions:

(a) A list of 11 items on the attitude to gender - typed activities traditionally ascribed to men and women were presented and the respondents were asked to evaluate using the 5-pt scale going from strongly agree, to strongly disagree.

(b) The respondents were asked to say Yes/No on 17 items on gender practices of their families in terms of conservatism and modernity.

RESULTS

1. The female rank holders in Science Courses were found to concentrate in Physics and Mathematics (Physics 28.6%; Maths 23.8%; Chemistry 14.3%; Zoology 9.5%; Botany 9.5%; & Home Science 9.5%; Biotechnology 4.8%). This finding corroborates the view of Eve Barboza and Frances Lovejoy as presented in GASAT 6 that the female underachievement in Mathematics in Western societies should

not blind us to the higher participation of Asian Women in Mathematics and Science (Action for Equity, 1991; p.536).

2. A startling revelation from the results of Table 2 is that all rank holders in Mathematics have been Brahmin girls, belonging to the higher caste group in the Indian social hierarchy. Caste/Community structure is the basis of Indian society and, for generations, Brahmins were the traditional teachers and custodians of wisdom. Other castes entered higher education only by the end of last century.

Table 2: Rankholders Caste-wise

Courses	Communities of the Rankholders		
	Brahmins %	Backward Communities %	SC/ST %
Maths	100	-	Nil
Physics	66.7	33.3	"
Chemistry	66.7	33.3	"
Bio-technology	100	-	"
Zoology	-	100	"
Botany	-	100	"
Home Science	-	100	"

It may also be observed that not a single girl from Schedule Caste/ Schedule Tribe (the lowest in the caste structure) has won the rank.

Besides, the diffidence of Brahmin girls to enter a course like Zoology reflects the Brahminic culture which is oriented in vegetarian practices and allergic to dissection of specimens in the laboratory except as a compulsory pre-requisite for Medical Courses.

3. All the respondents hail from middle class families.

Dr.A.K.Venkat Subramanian (Hindu, 11 Dec.1990, p.17) set the standard for Indian Middle Class an annual income ranging between Rs.25000 - 1,20,000 per annum. The family incomes of the respondents ranged between Rs.30,000 - Rs.60,000 per annum. It may be concluded that class also influences women's entry in tertiary science courses.

4. To the open ended question "What prompted you to choose the Course?", a large number (67%) expressed that they believed a high score in Science would get them attractive and status jobs. Only 25% declared that the choice was out of their own love for the subject. The rest (8%) stated that their choice was made under 'parents' compulsion'.

5. It appears that a teaching post in a college is the most desired career for the respondents (Table 3).

Table 3: Aspired and present Status/Career Choices

Status/Career Choices	Aspired Status/ Career %	Present Status /Career %
Teacher/Lecturer	66.7	33.3
Doctoral Degree	14.3	9.5
Self-Employment	-	-
Housewife	9.5	14.3
Undecided	9.5	14.3
Looking for a job after the completion of the Course/ better job than the present one	-	61.6

It was also observed that the salary of those who were in job was lower than that of Government employees. The monthly salary ranged from a meagre sum of Rs.750 to Rs.3340/-. Only one received Rs.4000/- as a Research Asst.

These under paid jobs were mostly relating to teaching profession. This reinforces the view that teaching is still one of the most sought after professions by women.

Those who were employed as teachers on a less attractive salary aimed at a better job in the teaching profession itself with assured promotion and higher salary.

6. Majority (90.4%) expressed that they were frustrated over the present status. There is a clash between their expectations that degree in Science would take them to career heights (an academic myth!) and the realities that the girls had to face later. I feel the compulsion to quote here what one of the respondents, presently working as Research Scholar in a Cancer Institute, has expressed:

> After completing my post-graduation, initially I wanted a lecturer's post in Nagercoil as my mother was all alone. I wanted to do part time research. None of the colleges was willing to employ me. They sent word that I had to give huge donations ... which shattered me to the core ... I've luckily joined this Institute but there are numerous meritorious students languishing at home. Our Government gives National Merit Scholarship (I have received it) for rank holding graduates for doing their post-graduation. But the real battle ground is employment. If merit students have to struggle like this, what to say about the sad fate of female graduates in our country!

The sentiments reflected in the above letter are supported by the responses to the question "Why are you not satisfied with the present position?" as given in Table 4.

Table 4: Reasons for Dissatisfaction

Reasons	%
Present position is not related to the Degree and rank obtained	36.8

Still in search of a job & therefore feel helpless	38
Fought for a way out but being a woman didn't succeed	15.8
Situation is corrupt and nothing can be done to change it	5.3

The frustration of these young merit scholars is part of the national scenario of unemployment.

7. The situation demands a deeper analysis. In case these rankholders had a strong personality and were not cowed down by traditional gender restrictions, would they have got a job? Activities reflecting the personality of the respondents 'in-job' and respondents 'not-in-job', were compared for differences. Results of Chi-square analysis between 'in-job' group and 'not-in-job' group on personality associated activities are given in Table 5.

Table 5: Activities reflecting personality

	Chi-square Value
Extra curricular activities interested	0.49
Prizes & Medals awarded for extracurricular excellence	1.08
Membership in Associations/Clubs	1.36
Reading Science articles & magazines	0.48

($df = 1$; $p < .05$)

The data presented in Table 5 show that career entry is not related to extracurricular achievements or excellence in activities related to personality growth.

8. Table 6 reveals the influence of gender-typing on career choices of the respondents. The respondents' attitude to gender typed activities as ascribed to men and women and the gender typing customs and practices as operative in families, in terms of conservatism and modernity, were measured.

Table 6: Gender Typing

	In-Job Group	Not-in-Job	t-value
Gender-typed activities	6.68 S.D	5.41 S.D	.87 N.S.
Modernity in Family	3.05 S.D	2.69 S.D	.87 N.S.

(df = 20; $p < .05$)

The table shows that there is no significant difference between the female rankholders who are in job and those who are not in job with regard to the customs and values observed in their families.

9. The data presented in Table 7 reveal that the Indian middle class families are in a culturally transcient stage and their attitude to gender ideologies is ambivalent in terms of social and religious customs as practiced in families (eg. The respondents who answered 'Yes' to the question "Is the family religious?" gave 'no' to the question "Does the family observe vrtas (religious fastings)".

Table 7: Modernity vs Traditional customs in families

	Modern	Traditional	t-value
Social & Religious Customs	3.20	3.30	.249 N.S.

(df = 20; $p < .05$)

This amlivalent attitude shows that there is no clear-cut division between traditional gender ideologies and modernity among the Indian middle class women today.

CONCLUSION

The female rankholders studied are in large number unemployed or under employed. They are ignorant of wider career choices relating to their Courses and resort to no-risk jobs like teaching. Self-employment is neither thought of not desired by them. Career choices of women, with a higher level of education, are more likely to be affected by social and institutional determinants than by gender

ideologies.

LIMITATIONS

The present study was conducted in the southern Universities. In view of the kaleidoscopic culture in India with numerous languages, regional differences and castes, the results cannot be generalised.

SUGGESTIONS

In India, a lot in the area of education, literacy, health, family planning, land improvement, minor irrigation, recovery of waste land and afforestation can be achieved by creating more career options for scientists and involving more female scientists.

There is a clear need for more effective career guidance through Career Seminars and Employment Guidance Cells. Science curriculum at the post-graduate level should be revamped with more inputs of practical applications.

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EDUCATIONAL HISTORIES OF A SELECTED GROUP OF FEMALE ACADEMIC BIOLOGISTS

Anne-Marie Scholer

Je propose de vous présenter les résultats de mon étude sur les expériences pédagogiques et professionnelles de quelques professeures de biologie. Ce projet m'a été inspiré d'un article de Sheila Widnall démontrant que le taux disproportionné de femmes dans les sciences est loin de diminuer une fois leur spécialité choisie. Les femmes quittent les sciences plus souvent que les hommes dans les collèges, ainsi que dans les écoles du cycle supérieur (Widnall, 1988). En outre, deux de ces professeures m'ont parlé du petit nombre de femmes qui présentent une demande pour des postes menant à la permanence, par rapport au nombre de détentrices d'une bourse de perfectionnement post-doctoral au sein de leurs établissements.

Dans le cadre de ce projet, j'ai interviewé vingt femmes qui ont terminé avec succès leur formation et ont obtenu de l'aide financière et un poste dans l'enseignement. Ces entrevues avaient pour but de découvrir les mécanismes de succès et d'adaptation auxquels ces femmes ont eu recours, qui, éventuellement, pourraient en guider d'autres. Les personnes interviewées se trouvaient à trois étapes différentes de leur vie professionnelle : premier poste dans l'enseignement, poste menant éventuellement à la permanence et poste permanent. Ces trois étapes ont permis de considérer le processus de différents points de vue. Les diverses étapes professionnelles peuvent également refléter des changements dans le domaine à cause du mouvement féministe, étant donné que les femmes plus âgées exerçaient déjà dans les années soixante-dix.

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EDUCATIONAL HISTORIES OF A SELECTED GROUP OF FEMALE ACADEMIC BIOLOGISTS

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ABSTRACT

I propose to present the results of my study of the educational and career experiences of practicing female academic biologists. This project was inspired by Sheila Widnall's article, which shows that the disproportionate attrition of females from science does not disappear once a college major is chosen. Women leave the sciences at a higher rate than men in college, and also in graduate school. (Widnall, 1988) In addition, two subjects have spoken to me of the marked scarcity of women they have seen applying for tenure-track positions, in comparison to the numbers of female post-doctoral fellows seen at their institutions.

In this project, I interviewed twenty women who have successfully navigated the training process, and have obtained both funding and an academic position. The purpose of the interviews is to discover mechanisms of success and coping used by these women which may be used to help others. The subjects are at three different stages in their careers: first academic position, at tenure decision, or fully established. This provides different perspective of the process. The different stages of career may also reflect changes in the field due to the women's movement, as the senior women were already practicing in the seventies.

INTRODUCTION

Events of the past few decades have removed many of the formal barriers facing a woman interested in a science career. However, women are still under-represented among those entering all but the social sciences. (National Science Foundation (NSF), 1992) This may be an indicator that opportunities are still inequitable.

Much of the current research on gender equity has focussed on creating and maintaining an interest in science

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

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and mathematics in school-aged girls. (Oakes, 1990; Jones & Wheatley, 1988) In the field of biology, the main problem is not a lack of interest, but a lack of continuation during or after college. This occurs in spite of the higher grades which women earn in science majors. (NSF, 1992; DeBoer, 1984)

This study focusses on professional education and early career formation. Data from both the National Science Foundation's 1992 study and from that quoted in Widnall's 1998 article indicate that attrition rates of women still exceed those of men at this late stage. The two years which I spent in a Ph.D. program in biology brought to my attention the tenuous and potentially isolated positions occupied by graduate students and young researchers in this field. This inspired my interest in the strategies, supports and abilities which have enabled others to survive and succeed as academic biologists.

SAMPLE

This study involved interviewing twenty women who had become academic biologists. Success was defined as having an academic position and conducting biological research. The chosen definition was my original career goal, and is not meant to imply that any other outcome is unsuccessful. The subjects were divided into three groups: new faculty within two years of receiving a tenure-track appointment, faculty who are up for or have just received tenure, and established faculty who are at least six years post-tenure. There were six new faculty, ages 35 to 40; six tenure-decision faculty, ages 39 to 45; and eight women in the established faculty group' with an age range of 45 to 78. The subjects were identified by networking: through the suggestions of advisors, colleagues, or other subjects.

METHODS

Each subject was interviewed once, and the interview was audio-taped. Each subject was asked to reflect on what she believes to be important factors in her educational and career history in responding to semi-directive questions. The questions also adressed interactions with peers and authority figures, any difficulties she might have had, her coping strategies, her view of self as a scientist, and what she would change in science education. Each interview transcript was submitted to the subject for corrections and approval. Identifying names and fields removed from the transcripts to preserve anonymity. The transcripts were then examined individually, and in groups for common themes.

RESULTS

Success and Coping

The main sustaining factors for this group of women were personal human support networks, strong self-esteem and independence, and a driving curiosity and love for science. Serendipity also played a role in some cases, in that some of the women attribute the choosing of a good advisor to luck.

Support networks included parents, high school and college faculty, spouses, advisors, laboratory supervisors, role models, and peers. Several women have mentioned the importance of support repeated during their interview: "...that sort of sustained me over some of these periods, when I'm sure I would have quit, had I not either been married, or had strong friends, or had strong advisors. There was always someone that sort of stepped in, right at a time that I was kind of...throwing up my hands." (018) "I think the thing that supported me the most in getting through was my family. And they helped me through." (022)

Some women spoke of the lack of a support network, and

it's possible effect on their careers. "But I have often felt like, if I'd had more support, I could have done more. I could have done better." (023)

Other women related infrequent support, or did not speak of it as an important factor for their success. Many of these women showed great independence: obtaining advice and dealing with problems directly, as witnessed in their descriptions of coping with problems. In regards to gender discrimination, one woman said: "...in a sense it's part of the charm of being a woman in science, or in any kind of profession... I've really actually started enjoying being in those kinds of situation, because it's such a challenge." (020) In answering questions about success and milestones, these women showed signs of strong self-esteem. "...I have decided what is successful for me. And I certainly think that I have achieved most of what I had set out to do." (006) "I'm doing what I want to do. And getting paid for my hobby. How much more successful can you be?" (011)

There were a few cases where a woman also spoke of having limited support, and experienced at least one period of low self-esteem. "I don't see myself as a role model for a young woman who wants to go into (her field). I don't feel like I have anything to offer them. " (023) This same woman also told me she did not believe herself to be successful. One third of the subjects spoke of the frustrations inherent in laboratory science. When asked about coping with fights with advisors or failed experiments, one women responded: "Oh, the standard life? (022) "I developed a philosophy for experiments not working, and for grants: the suffering index. You suffer and suffer and suffer, and then all of a sudden things start working." (010) In the face of the inherent frustrations and other difficulties, these women seem to have been

sustained by a love of science and the desire to answer their research questions.

The love of science is almost palpable in all of these women. In answering `What is the essence of science?', almost all of the subjects became animated. "What fun science is. Even though all the pain and heartache and everything. That one moment when something falls together, it's like Christmas. New Years. All rolled up into one." (010) "Knowing more tomorrow than I did today. And that's fun, and that's amazing." (019)

To uncover coping strategies, I asked the subjects how they responded to arguments with advisors, and with failed experiments. The answers varied from direct action, to burying oneself in lab work. Direct action was seen as the most effective method. "So, I'd say throwing up one's hands in dismay is probably worthwhile doing for the first five minutes, and then the best antidote is action. And action that is decisive and directed." (017) Direct action consists of confronting problems head-on. "..in the first case we just talked about things until they were resolved, and in the second case I just tried other approaches to the experiment." (013) This coping method requires self-confidence. One must be able to defend one's point of view, and not see failed experiments as due to personal worthlessness.

Another popular method is talking troubles over with peers and other supporters, which requires the availability of such. This can be a particular problem in early graduate school. "This feeling that there was no support network. You were just kind of hanging out there.' (022) Peers and advisors provide good support, because they have experience with the system, and can offer practical advice and validation. They can also advise and network once the student has

started her own lab. "When I for instance had a terrible fight with the person at (her first job): the next day I called `fifty of my closest friends', looking for jobs anywhere in the country." (017)

Detaching from science is another coping method employed by some of the women. "If I had a particularly bad day, I would go play racquetball; and hit the ball and pretend it was my major professor...And after I met my husband, I still had sports, but I also had someone to complain to." (022) "...in grad. school, my usual reaction was to sort of disengage, and bury my head in a book or something." (021)

The last coping method, and perhaps least productive one, is to bury oneself in laboratory work. Most of the women who used this method did so only during graduate school. "As a graduate student, I was so mixed up, that half of the time I would just work through the night. That never really produced the appropriate amount of awesome data at the other end that I thought it would." (017)

Subject-Suggested Changes

During the course of the interviews, the subjects suggested changes which would have improved their own experiences, or would serve as an aid to women in science. In the field of science education, these suggestions include: stop inhibiting girls from pursuing science and mathematics; provide more good female role models; increase the amount of science education; and increase hands-on and thinking, while decreasing rote learning in both grade school and college science courses.

In graduate education, the major concern was improving the quality of the mentorring experience. The suggestions for increasing the likelihood of a good match of personality and interests were: (1) to make three lab rotations mandatory

before choosing an advisor, and (2) to label the "jerks" as not worthy of being an advisor. The other graduate school concerns were communication skills, and social support. "...a village culture for young scientists (is) very good. Where there are groups of people, either peers or mentors, or mentor-sort of supporting peer groups and so on, that allow people to talk about science... (A place where) it's OK to fail, and to go on and to learn from that. Not just to fail and to learn how awful you feel when you fail, but to fail and to be able to back off and say, 'OK, how could I have done it differently?'" (015)

There is a theme of needed change in science and society if women are going to establish a comfortable balance a family and a scientific career. A scientist who wishes to be a parent is still suspected of not being serious about her career. "... there has been a bias against women having private lives in science, that I think is very detrimental. I'm thirty-nine; I'm terrified to have a child. ...I haven't had any encouragement that it would be OK to have one and still be an effective scientist." (017) This theme shows up also in the descriptions of unsupportive ex-spouses, and in the praise which some of the current spouses receive. "...my husband now is just wonderful. Working on this grant in the last two months, he's done essentially everything at home." (023) A few women suggested the academic career be changed to better allow for raising of small children. However, one woman warned, "What I don't like about this idea (more time to tenure for women) is that it suggests that women should continue to provide most of the care-giving and nurturing required in a family situation." (016)

Two of the senior women asked me of young women: "why (do) we see them do so terrifically well as students, ...and

the ones who go on to post-doc. do terrifically well as post-docs., and then somehow the pool of available women seems to shrink at that point. And I don't know where the black hole is, that they fall into." (011) Some of the younger women offered their own theories, all related to the perceived difficulty of managing a scientific career and a family in the United States. One tenure-time woman with small children said, "My being a role model in this sense is actually not entirely positive; because there are people who see me, and they say to me, `You know, I'm not going to do what you're doing. That's too hard.' And it is hard." (019)

CONCLUSIONS

Role models have been important to several of the women in this study. However, for most of the women, exposure to good science teaching and actual laboratory experience have been the important factors. A female high school teacher who "..taught us so much advanced biochemistry at that young age, that I was convinced that this was the hottest thing that I had ever heard." (017) "...when I actually did research, that was it." (023)

The lower self-confidence of the younger women, and the mention of self-esteem battering in graduate school by three of those women implies that there may be insufficient support for those in the training process. As one woman stated, isolation and excessive pressure do not provide a good environment for risk taking and learning from mistakes.

Peer groups have been cited for encouragement, positive competition, problem solving, aid in job-finding, lateral role-modelling, and the prevention of at least one woman from quitting science. These groups should be encouraged to form at all levels of education.

Mandatory lab rotations increase the number of inves-

tigators that a student experiences, but this does not guarantee finding a good advisor. Perhaps intra-departmental meetings with senior graduate students would help a student choose the best possible rotation candidates.

Some schools have a system of mentorring for junior faculty, to help them get started in teaching, departmental policies, and the business and networking end of science. However, at this point such systems are rare, and in some cases are not being put to practice.

Finally, it may be wise to either establish some flexibility to the tenure track to allow for parenting, and for dealing with family crises.

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DEVELOPING AN INCLUSIVE TECHNOSCIENCE LEARNING ENVIRONMENT

Gilda Segal and Mark Cosgrove

Les élèves-maîtresses de niveau primaires s'estiment souvent exclues du secteur de la technologie et des sciences (technosciences) en raison, en partie, des points de vue formalistes et abstraits du savoir et de sa construction, qui conduisent à des méthodes d'enseignement des sciences insensibles. Pour aborder ces questions et éliminer de telles attitudes négatives, nous avons conçu un modèle d'apprentissage basé sur trois thèmes. Nous avons réuni l'efficacité des groupes collectifs et l'apprentissage fondé sur les propres questions des apprenantes et apprenants situés dans des contextes technologiques importants du point de vue social. Nous décrivons ici une étude de cas dans laquelle cet environnement d'apprentissage à trois composantes a aidé deux élèves-maîtresses à surmonter leur anxiété et leur manque d'assurance et à tirer meilleur parti de leur situation.

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ABSTRACT

Female primary student teachers often feel excluded from technology and science, (= technoscience) due in part to formalist and abstract views of knowledge and its construction which lead to insensitive science teaching methods. To confront these issues and offset such negative attitudes, we devised a learning model based on three themes. We blended the efficacy of co-operative groups with learning based on learners' own questions located in socially significant technological contexts. Here we describe a case study in which that three-stranded learning environment helped two women student-teachers to offset their anxiety and low confidence and to make powerful cognitive gains.

INTRODUCTION

Some final year primary teacher education students assume that science is ready-made and that it is inaccessible to female learners; further they hold that the business of science educators is to instruct learners in this ready-made science rather than to provide opportunities for learners to construct knowledge for themselves (Papert, 1990). We wanted to challenge these assumptions by creating a learning environment which, like that envisaged by Duckworth (1987), would allow students to be inventive, to have wonderful ideas and to analyse critically their own ideas and those of others, just as scientists do.

An authentic feeling for science is rarely gained without feelings of anxiety, as correct answers may not be readily accessible or even exist. For some students,

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who have never been given responsibility in their own formal learning, excessive anxiety may block access to learning; this dilemma requires special attention.

Against this background of challenging much existing pedagogical practice, we pose a question which is crucial to the education of female primary student teachers: should women and girls be allowed not to participate in technoscience education? (We have adopted Latour's (1987) word, technoscience, to describe the unitary nature of this context for learning). If female students decide that their interests lie elsewhere, have educators the right to insist that those students participate in more learning of a type that many of them wish to reject? Or, as we contend in this paper, do educators have responsibilities to investigate alternative ways in which scientific and technological fields may be made accessible to all?

By acting as role models for their female pupils, many primary student teachers, already lacking confidence in their science capability (D.E.E.T., 1989; Klindworth, Martin & Tytler, 1991) could perpetuate myths of technoscience as masculine, remote from the normal interests of girls and feminine women (Eccles, 1987). As teacher educators, we are trying to interrupt this cycle. Here we attempted to re-open technoscience to a group of young women, most of whom were disaffected science learners, as they were about to complete the final semester of their course of primary teacher education.

1 A model for teaching and learning

Our model has three strands, constructed from cooperative learning groups, learners' questions and a context chosen for its technoscience suitability as a learning environment for females who are disaffected or insecure science learners. (Reasons for this disaffection range from boredom to lack of inherent interest to lack of previous success.) Each strand of the model is grounded in a long line of research; for example, Sharan, (1990) on cooperative learning; Biddulph (1989) on learners' questions; Cosgrove, 1989 on context. The role and significance of each strand, and in particular, the choice of refrigeration as

a technoscience context, has been explained (Cosgrove, Newman & Forret, 1987; Segal & Cosgrove, in press).

2 Creating a technoscience learning environment

Our aim is to create an inclusive learning environment within a technological context from which learners can extract significant science ideas, with help available. As part of this process, students puzzle away at observations until explanatory ideas emerge and some even reach the stage of resolving theory conflict in favour of those productive, encompassing theories which are valued for their use and their elegance. As we knew that this type of learning would not be customary for our students, we devised a supportive teaching/learning model and planned a slow, friendly introduction.

THE STUDY

In this study were 27 student teachers enrolled in a background elective subject. Details of the nature of the activities, the research methodology and of the learning and reactions of the class in general, are given elsewhere (Segal & Cosgrove, in press).

Here we report on the learning of two friends, Mary and Simone, aged 20. After describing and discussing our prolonged interaction with them, we briefly compare outcomes of their learning and achievement with that of the majority of other class members. In the final section, we comment on the significance of the case study.

A CASE STUDY OF DEEP LEARNING

Mary and Simone: an initial picture

Although Mary and Simone did not rank science among their favourite school or university subjects they retained positive feelings about science from their high school experiences; however both described themselves as having feelings of inadequacy in science - Simone in learning it and Mary in teaching it.

Mary and Simone did not draw attention to themselves in any way, in the early sessions of the class. They blended into the general group, participating in a variety of activities such as dry ice making. Like the majority, they seemed reluctant to approach the heat pumps or to make sketches of the equipment.

Mary and Simone: passive at first

In session three, Simone and Mary, like most other students, were sitting quietly, seemingly trying to appear busy. Unbeknown to students, our strategy was to wait patiently until students were ready to converse with us about any aspects of the materials they wished to raise. Noticing a drinking duck, they joined G.S. first in investigating it and then in viewing a slide set with taped commentary about how fridges work. Then they accompanied G.S. to examine a fridge. Here, for the first time, both students began to learn by thinking.

Mary and Simone: problem solving

Initially, Mary and Simone tried to identify the parts of the fridge from those named in the slide set. This was not straightforward, as the slide set diagrams were schematic and the parts were not positioned to correspond to a real refrigerator. As they tried to trace the circulation of the refrigerant, by identifying the hot and cold parts, they vigorously asked questions, made exploratory statements and offered tentative explanations. This inquiry led them to note many puzzling situations. They pondered over the observation that there seemed to be a single path into and out of the evaporator (cold surface), whereas they thought there should have been a separate entrance and exit. Mary speculated about the function of a "pot" (pump) - could it also have a condensing function as it is hot? This fitted her idea of the condenser (hot surface) releasing heat to the air. Their discourse was insightful, culminating with Mary's question "How does it get so cold again after being so hot?" This is the crux of our approach, cognitively; to provide the conditions in which students can formulate the questions which, when answered, provide powerful insights.

Mary and Simone: the joyful experience of having wonderful ideas

During the extended discussion, one of us (G.S.) was present throughout, participating as a co-learner. Earlier, G.S. did not attempt to disguise the fact that she too was having difficulty reconciling the diagrams and the fridge, and this may have been one reason that Mary and Simone were willing to construct their learning in her presence, with the accompanying risks of displaying ignorance or ineptitude. Finally, after adopting M.C.'s timely suggestion of measuring the temperature along the path, they make sense of the whole cycle, in the exchange below, to their great satisfaction.

S So why is it hot here?
G.S. And where does it get cold?
M Oh look! See. Oh yeah, all right, so its hot coming in and then it gets squeezed through the little tiny area like that stuff over there did maybe.
S Mmm.
M And so it gets cold here. So!
S Where does it come out from?
M It comes back out - it comes through there.
S Oh look, it does too.
M And goes back out. That's so clever! Oh good! and that's it, isn't it?
S That's just how it works?
G.S. Yes.
M We were really worried that we'd never know, (laughs). Oh good!

During this section of their problem solving, not only did they find that the coldest part occurs as the tube becomes very narrow, but Mary linked this to the formation of dry ice in the demonstration of the week before, ("like that stuff over there did"). Temperature measurements resolved the puzzle of the refrigerant seemingly entering and leaving the evaporator by the same tube, by making clear not only the direction of the refrigerant through the evaporator, but also that there must be two concentric tubes for entry and exit. Mary appreciated this design as she remarked, "That's so clever!" Again, this insight - her own personal understanding of somebody else's idea - is compelling.

Mary and Simone: conversations can reveal conceptions

As further questions arose about the nature of the refrigerant and possible changes of state at various points in the cycle, Simone said: "Heat's steam, isn't it? Can it make it into steam, do you reckon?" Here she revealed her conception of heat as a substance and its role in the change of state of freon when heated. In this non-threatening conversational atmosphere, Simone felt confident enough to reveal her underlying views about heat. We claim that these intuitive ideas of reserved students are usually difficult to access under direct questioning.

Mary and Simone: quality of learning

We thought that Simone and Mary would understand refrigeration better than other students who presented carefully copied (from books) descriptions and diagrams of working refrigerators as part of their projects. Four weeks after the refrigeration section had concluded and without prior notice, the students were asked to record their ideas about refrigeration. Mary's and Simone's answers (and those of others who had participated in this mode of learning), evidenced greater detail and insight - deeper learning - (Entwistle, 1988) than the answers of students who had taken one of the alternative pathways we had provided as a safety net. Also, both Mary and Simone commented upon their increased self esteem and their intention to apply such methods in their future classes.

It appears to us that social, cognitive and contextual factors, linked together in the conversational structure of our learning model have each supported Mary's and Simone's learning.

DISCUSSION

In more traditional science courses, a logical order, (the linear sequence of points defined by the discipline), prevails, where a topic is introduced through definitions followed by confirmatory demonstrations (sometimes this order is reversed); there may then be discussion about applications. The outcomes of

such learning are as depressing as they are well known.

Recent efforts to improve technoscience learning have concentrated upon exposing and modifying students' intuitive knowledge. We recognise the importance of that work and have contributed to it (eg Cosgrove and Osborne, 1985), but we are concerned that this shift towards science learning as conceptual change is both unbalanced and is likely to obscure other important requirements for learning. Here we have examined two.

First, there may be a psychological order of treatment of a topic which is preferable and different from its logical order. In this case (after the topic of refrigeration was justified as worthwhile), the learning started with students examining operating heat pump systems. Embedded in that equipment is a network of ideas and activities which students dissected and deconstructed until they identified the questions that were crucial for their understanding, questions such as 'where does the cold come from?' based upon conversations we held.

Secondly, we have been able to create conditions for learning in which these two students began to overcome the legacy of dependence from their formal education. We attribute this in part to a mode of discourse based upon conservations students held with us when they were ready. It was our intention to replicate the type of learning Richard Feynmann remembered:

> That's the way I was educated by my father, with those kinds of examples and discussions: no pressure - just lovely, interesting discussions....(p.17).

Sensitive approaches to learning may help primary student teachers to re-enter technoscience learning.

We claim that the success experienced by Mary and Simone justifies our patient waiting for them to engage in an intellectual adventure that initially did not attract them. We hope that Simone, Mary and other students will create inclusive learning environments when they become teachers.

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COMPETITION AS A MARKER FOR SUCCESS IN SCIENCE

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La compétitivité et la volonté de se montrer compétitif sont de précieuses qualités dans le domaine des sciences. Ce document examine l'information existante sur la compétitivité et le succès, et explore la relation entre la confiance en soi et les accomplissements scientifiques des étudiantes et étudiants en route pour des études collégiales.

L'étude s'est penchée sur un groupe d'étudiantes et d'étudiants de première année d'un collège d'arts libéraux mixte hautement sélectif offrant un programme de quatre ans. Toutes et tous ont obtenu des résultats supérieurs à la moyenne dans différents tests d'habiletés scolaires oraux et mathématiques. Les étudiantes en sciences se sont décrites comme étant plus compétitives que celles des autres domaines académiques. Toutefois, même les étudiantes en sciences étaient moins portées à se décrire comme étant compétitives que les groupes composés strictement d'hommes poursuivant des études scientifiques. La compétitivité des étudiantes a été comparée à des auto-évaluations de la confiance personnelle et académique et des aptitudes. Aucun lien significatif n'a pu être démontré.

Les données ont confirmé les hypothèses de l'étude qu'il existait des différences entre les deux sexes en ce qui a trait à la volonté de prouver sa compétitivité et que la compétitivité des femmes n'était reliée ni à la confiance en soi ni aux performances, et nous ont mis en garde contre l'emploi de la compétitivité comme un indicateur de succès.

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COMPETITION AS A MARKER FOR SUCCESS IN SCIENCE

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ABSTRACT

Competitiveness and a willingness to present oneself as being competitive are qualities positively valued in science. This paper reviews the literature on competition and success and explores the relationship between competition self-confidence and science achievement in college bound students.

Subjects for the study were first-year male and female students at a four year co-educational highly selective liberal arts college. All tested above the median national SAT or ACT verbal and mathematics scores. Science-females described themselves as being more competitive than did those who elected other academic areas. However, even the science-females were noticeably less likely to describe themselves as being competitive than were either the science- or the all-male groups. The differences between all-female and the male groups were statistically significant. Female competitiveness was compared with self-reports of personal and academic confidence and of ability. Neither relationship was significant.

The data confirmed the research hypotheses that there was a gender bias in willingness to present oneself as being competitive and that female competitiveness was related to neither self-confidence or performance, and argued for exercising caution in using competition as a marker for success.

INTRODUCTION

Competition is a quality highly valued in practitioners of science (Maddox, et al., 1990; Chambers, 1983), but is it a necessary one? If it is, females may find themselves disadvantaged in seeking entry and promotion. That women and girls, relative to men and boys, less often report a willingness to compete has been well documented (Lenney, 1977, and Maccoby & Jacklin, 1974, for reviews of the early literature; Deaux, 1979;

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Frey & Ruble, 1987; Gold, Brush, & Sprotzer, 1980). No investigation has been made, however, of the extent to which women who enter science reflect this pattern. Nor has there been an investigation of the relationship between willingness to compete and success in science. This paper begins to do so.

METHOD

In the fall of 1991 and again in the fall of 1992, male and female first-year Gustavus students (in all 543 males and 667 females) were surveyed regarding interest in science, willingness to compete, and ability. The survey was made the first days the students were on campus. The survey instrument was the American Council on Education (ACE) Cooperative Institutional Research Program (CIRP) Freshman Information Form (FIF). To control for ability in the data analysis, Scholastic Aptitude Test (SAT) scores or the American College Testing Program (ACT) scores were also obtained.

The variables studied were competitiveness, intellectual self-confidence, mathematics and general academic ability, social self-confidence; drive to achieve, and sex, major, and career interest. The variables competitiveness through drive to achieve and competitiveness were measured on a 5 point Likert type scale –eg. bottom 10%, below average, average, above average, and top 10%. Major and occupation interest were coded from lists including over 80 majors and over 40 occupations.

The variables were analyzed to test the following propositions:

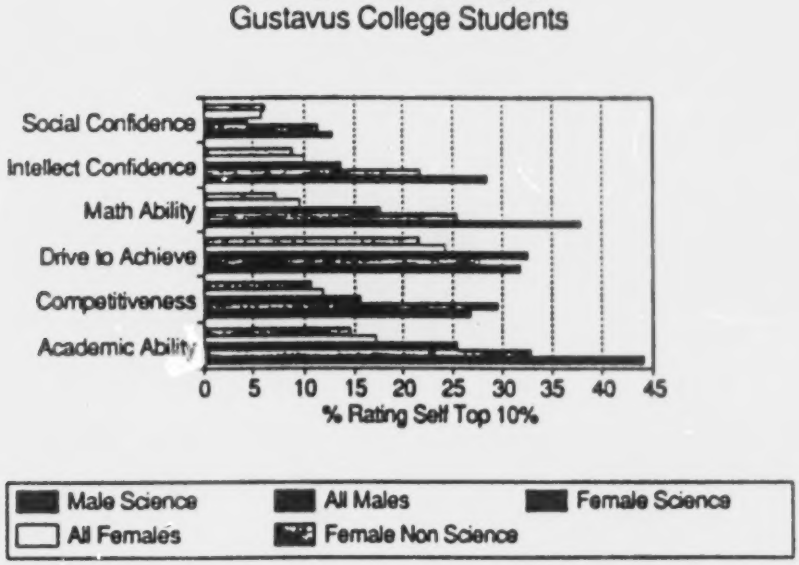
1) Females will be significantly less likely than males to identify themselves as being competitive;

2) Female competitiveness will vary moderately with interest in science but will not reach statistical significance;
3) Competitiveness is related to drive to achieve in science oriented females;
4) Competitiveness is not strongly related to social and intellectual self-confidence in science oriented females.

Data sets were included in the study for which the respondent's SAT or ACE scores fell at or above the national median for college admissions (255 males, 317 females from 1991; 256 males, 322 females from 1992). Data for the 1991 and 1992 samples were then compared. No significant differences were found, so the responses from the two years were combined for the remainder of the analyses. The responses were then analyzed by 5 groups: all-female, all-male, female-science, female non-science, and male-science. Respondents were classified as science-bound if they had so designated interest on the major or career survey items. Chi square and a Pearson test were used to measure significance.

RESULTS

Consistent with the first proposition, the female respondents described themselves as being less competitive than males. Also, their ratings of intellectual self-confidence, academic ability, competence in mathematics, social self-confidence were significantly lower ($p<.01$) than those of the males. The effect held for science oriented females ($p<.01$) as well as those who did not indicate interest in science. Drive to achieve, in all cases, was comparable. Consistent with the second proposition, science-females were



more competitive than the other females, but the differences between them were not significant ($p<.10$). The third and fourth propositions were supported in that competitiveness was found to be related to self-reports of drive to achieve ($p<.01$) and to academic abilities ($p<.01$), but not to intellectual ($p<.02$) or social ($p<.22$) self-confidence.

DISCUSSION

Study data argue that science bound females show the same pattern that women in other career paths do. All present themselves as being less competitive and less driven to achieve than do their male peers. They also all appear to do so quite apart from their confidence in their ability to succeed socially and intellectually.

What this sex difference means and whether differences in male and female self-reports of competitiveness are due to some other lack of

confidence or because of social inhibition in self-presentation has been debated widely. Corbin (1981), in an often quoted study, argued that females were less competitive because they were less confident; and that because females were less confident, they were objectively less able to succeed under competitive conditions. He showed that they not only reported themselves differently on the matter of competition, but that they were less able than males to take competitive advantage. His effect disappeared, however when Hall (1990) replicated his study, controlling for ability and practice effects.

Recent opinion agrees with Hall that the differences do not reflect ability to compete but relate to social inhibition. Lenney (1977) concluded that there was no clear relationship between a female's presentation of self as non-competitive and her ability to compete. She argued that females were competitive, but that they evaluated their willingness to compete downward when asked to describe themselves. A number of studies (Crandall, 1969; Jacobson, Berger, & Milham, 1970; House & Perney, 1974; Gould & Slone, 1982) support her position. Berg et al. (1981) found also that women lowered estimates of their willingness to compete when asked to consider tasks at which men were traditionally expected to excel –eg. tasks which were potentially gender-inappropriate (cf. Gitelson et al., 1982; Lenney, 1981; Lippa & Beauvais, 1983; McMahan, 1982; Stein, Pohly, & Mueller, 1971). In the words of Berg et al. (1981) "women who consider themselves to be feminine and who are concerned with the evaluations of others may not wish to have

others perceive them as possessing masculine abilities" (p. 725).

Heilman and Kram (1978) demonstrated that females were particularly reluctant to compete when the competitor was male, hinting that female hesitation to compete had more to do with saving face for males than reluctance to perform. Bradley (1978), analyzing male behavior, suggested that the male's tendency to present self as competitive might not so much signal ability and self-confidence as be a move to increase self-esteem--a strategic bluff and a frequently successful demand bid for non task-related respect and deference. Gould and Slone (1982) concluded that females might just be more modest. Daubman et al. (1992; Roberts & Nolen-Hoeksema, 1989; Roberts, 1991) suggested both females were modest, and that they were motivated by social concern. "They were . . . motivated out of a concern to protect the other [in the competitive situation] from a negative social comparison, thereby protecting the *other's* self-esteem" (Daubman et al., p. 198).

The tendency to present oneself as competitive is gender-related and does not, for females at least, appear to be correlated with ability, willingness to work, science contrasted with other work areas, or motivation to succeed. Not only do females compete differently than men, but their reasons for doing so appears to be very different. It would appear that further investigation into the role of competition in performance is in order and that one should exercise caution in either explicitly or implicitly using

competition as a marker for success in science.

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TRACKING THE ASPIRATIONS AND ACHIEVEMENTS OF ABLE FEMALE STUDENTS IN A DISCRETE URBAN AREA

Jillian Spink

Basingstoke, Hampshire, est considéré comme une région technologiquement très prospère. Des recherches locales ont démontré que les étudiantes qualifiées, qui obtenaient de bons résultats en sciences à l'âge de 16 ans, ne choisissaient pas de poursuivre leurs études dans ce domaine et que cette tendance semblait encore plus évidente dans un quartier spécifique de la ville. Ce quartier compte plusieurs immeubles municipaux, construits pour absorber un grand nombre de londoniennes et londoniens vivant dans des taudis. Toutefois, il semblerait que ces personnes aient établi leur propre sous-culture discrète, influençant fortement les attitudes et le comportement des familles. Les jeunes femmes y vivant montraient de moins bons résultats que leurs homologues masculins, contrairement à la tendance nationale, et manquaient d'ardeur à suivre des cours théoriques après l'âge de 16 ans. Celles qui poursuivaient leurs études choisissaient généralement des cours professionnels et limitaient leurs horizons au collège du côté nord de la ville. La pression des camarades et des parents influençaient fortement ces jeunes femmes et beaucoup d'entre elles se conformaient à la tradition d'une vie de famille précoce, se mariaient presque automatiquement à un homme vivant dans le même quartier, et devenaient rapidement mères.

Bref, une division culturelle nord/sud restreignait les aspirations, les réalisations et les attitudes des jeunes femmes des quartiers du nord de Basingstoke. Ce document confirme l'ampleur du problème et fait état du travail réalisé en vue de trouver des solutions. Ce travail inclut une étude qui suivra ces jeunes femmes tout au long de leurs études au collège jusque dans leur carrière, jusqu'en juillet 1994. En plus de cela, les écoles desservant la région participent activement à la recherche de stratégies visant à modifier les attitudes culturelles ancrées au sein des collectivités très serrées de Basingstoke nord. Leurs activités de planification et de mise en oeuvre seront incluses dans le cadre de l'étude à long terme.

TRACKING THE ASPIRATIONS AND ACHIEVEMENTS OF ABLE FEMALE STUDENTS IN A DISCRETE URBAN AREA

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ABSTRACT

Basingstoke, Hampshire is regarded as a high tech prosperous area. Previous local research had shown that able female students obtaining good examination results in the Sciences at 16 did not choose to continue to study in those subjects and that this trend seemed more noticeable in one specific area of the town. The area had been developed with a number of council estates to absorb large numbers of Londoners in a slum clearance scheme, yet it appeared to have established its own discrete sub-culture which strongly influenced the attitudes and behaviour of family groups. Young women there performed less well than their male counterparts, contrary to our own National trend, and were reluctant to follow academic courses i.e. post 16. Those who continued their education generally opted for the vocational courses and limited their horizons to the college in the North side of the town. Peer and parental pressures strongly influenced those young women and many adopted a tradition of early marriage, almost certainly to someone living in the same locality, and children.

In short a cultural North/South divide was restricting the aspirations, achievements and attitudes of young women in the Northern area of Basingstoke. This paper confirms the extent of the problem and reports the work being done to develop solutions. That work includes a study which will continue to follow these young women through their college courses and into employment until July 1994. In addition the schools serving the area are actively involved in finding strategies to change the deeply held cultural attitudes within the tightly knit communities of North Basingstoke. Their planning and implementations will be included within the scope of the long term study.

INTRODUCTION

There is ample evidence that teachers in Britain have a lower expectation of girls' intellectual capacity than of boys'; and that girls have a lower opinion of their own abilities than do boys (Chandler 1980; Deem 1984; Mahony 1985). There is also evidence that in mixed schools there is considerable social pressure for girls to underachieve (Chandler 1980; Mahony 1985).

Women in work in Britain are found in a very limited range of occupations. The notion that the foundations for this phenomenon are laid in schools has led to a large number of research projects aimed at encouraging girls and young women to aspire to a greater variety and higher levels of occupation (for example Chisholm and Holland 1986). Girls seem to be less specific about career aspirations and to aim lower than boys of similar ability (Kerr 1983). There is little evidence to suggest that there is an imbalance in the numbers of able boys and girls in schools, yet under representation of women in senior positions is widespread. That implies a waste of female talent, a neglect of women's potential contribution to the economy, and a reinforcement of "traditional" views of women's place in society.

While Education cannot be blamed exclusively for women's disadvantages in employment and in society, some of the causes can be traced back through the education system, even to the earliest days of educational experience (Brierley 1991). Teachers differentiate unconsciously between boys and girls in primary schools and the lack of role models in secondary and further education can make matters worse. As an exemplar women make up 59% of the school teaching workforce, but fill only 4.35% of the headships, (TUC 1987).

PREVIOUS BASINGSTOKE RESEARCH

Twenty years ago it was planned that the small market town of Basingstoke would absorb several thousand Londoners from slum clearance sites, and large estates of council housing were built on the North side of the town to accommodate those overspill populations. In parallel, as the town expanded, major companies were

attracted to prestige office buildings in the town centre, and Basingstoke is now regarded as a high-tech, prosperous area. It is served by nine mixed comprehensive schools and two large colleges of further education. The headteachers and principals are all male, with eight female deputies and fifteen male deputies within the institutions, although four institutions still function with all male senior management teams.

My early research had shown that able female students attaining good examination results in the sciences at 16 did not choose to continue to study in these subjects (TVEI 1990). Available local data did not however differentiate between the schools in the area. Separately, in 1990, a report on the attitudes of young people in Basingstoke to the provision of local education and training opportunities suggested inter alia a social divide between North and South in the town. It observed:-

'Culturally, there appears to be a North/South divide between the Basingstoke schools. There are three North Basingstoke schools and each of these schools serves areas which include large council estates and many of the pupils come from working class families. The schools in the South of the town serve many more families from mixed estates and estates of privately owned houses, as well as children from the surrounding villages, and there is a much greater diversity of family background' (Wiggins, 1990).

CURRENT STUDY

As a result, and reflecting increasing concern from industry and commerce, I focused on tracking the aspirations and achievements of North Basingstoke females entering

903

the colleges. Five cohorts of young women were identified for the study and interviews began in September 1991 with a cohort of Year 11 students. (The interviews will continue until July 1994 when the second cohort will reach Year 13 of their education or training.) Emerging results tended to support the notion of a North/South divide. Firstly, the interview programme revealed a substantial difference in the attitudes and aspirations of the young women according to which school they attended. That analysis of attitude by school also identified clearly two geographic groups. Secondly, the GCSE results for the two areas were different. The students in the South of the town generally demonstrated more success, with the female students gaining 17% more 'five GCSE subjects at grade A-C' than the males. In what are considered to be the more academic schools this rises to 26%. In the North Basingstoke schools the average achievement is below the South and in two schools (whose catchment areas include the London overspill estates) boys have achieved 11% more passes at 'five GCSE subjects at grade A-C' than the girls. That is noticeably the reverse of our National trend.

Furthermore the divide also appeared to be cultural. It transpired that options for subject choice at 14 years were considered differently by girls in the two areas. On the whole the girls in the South schools weigh up a variety of alternatives and consider their future aspirations (both academic and career) before making a personal decision. The decision is guided by parents and careers co-ordinators who expect the students to be ambitious. In the North schools, the girls are influenced by their peer group and parental pressure to choose 'suitable and useful' subjects.

In general they seem to interpret this as a stereotyped future of early marriage and children. Few girls in the North consider themselves able to attend a college to pursue further study particularly in the 'more academic' areas of science and mathematics. Several young women enjoying science in school were not prepared to attempt further courses as they believed they had, or would soon, reach their 'academic limit'. A group of five good science students informed me that they were intending to study Arts subjects at 16+ as they were "easier and more useful".

EXPERIENCES OF COLLEGES

North Basingstoke students mainly feed into the vocationally orientated College of Technology (based in the North) and the South students the academically based Sixth Form College in the Southern area. There is a distinct reluctance for girls from the North Basingstoke schools to attend the Sixth Form College and those that do venture to attend report isolation and loneliness at first. It is significant here that a proportion of students attending the Sixth Form College come from public schools and the majority are from schools in the South of Basingstoke. The young people from North Basingstoke schools felt that they were considered inferior in some way and they feared that they would encounter prejudice from fellow students. Some students, but particularly the girls, believed that, as attendees at the Sixth Form College they did encounter the prejudice they expected. How much of this was due to the retiring attitude of a minority population I have not investigated.

The staying on rate at both colleges in 1992 in Basingstoke is 70%, with 75% rate for pupils from South schools and 57% rate for those from North schools. Although

these rates were higher this year than ever before, the improvement may be illusory. Basingstoke has been hit by the recession and very few companies are recruiting; those which are, report a preference for 'experienced' personnel rather than school leavers, (TVEI 1992).

Of the college students from North Basingstoke schools 30% attended the vocational orientated College of Technology. Female students dominated the courses in Personal Services and Administration, yet only a minority of female students entered the Science department courses at the college. The female students following science BTEC courses reported a positive attitude towards the courses. A student entering the course straight from school reported that she felt unhappy and lonely at first but was enjoying the course and its orientation towards work place contexts. She also enjoyed the good working relationship with the lecturers and said that she felt encouraged that she would succeed beyond the limited expectations of her old school and parents. The BTEC diploma course was highly regarded by the female students whose age range was 16 years to 24 years. Some of them had previously followed other vocational courses in another college or had followed academic courses in the Sixth Form College; despite successful completion, their results had not adequately equipped them for jobs or careers. One student, who had attended a North Basingstoke school, expressed her resentment about the lack of educational expectation at the school and she had drifted into several dead end jobs before her success on an access course at the College had encouraged her to embark on a full time BTEC diploma. She felt she was eight years behind in her career.

STRATEGIES FOR CHANGE

A tutor for access courses at the College of Technology reported a number of young married females with children entering the courses. Most of these women were married with children before they were 21 years and all felt that they had been disadvantaged at school. Hopefully, this new generation of women entering training courses will recognise the value of educational opportunities for their daughters and this may begin to change the cultural attitudes of the North Basingstoke families. Promotion of such necessary change cannot however be left to chance; positive strategies are required if attitudes and culture are to be altered.

The North Basingstoke schools are aware of and are actively addressing these major problems. One school has an eight point action plan, developed as a direct product of discussion with the colleges. The majority of the points are aimed at giving more accessible information to students, staff and parents, whilst others concentrate on the groupings of students at the Sixth Form College and the establishment of two way staff contacts. A second school has organised a half day seminar at the Sixth Form College for twenty staff. The same school is planning a questionnaire for ex-pupils on their college experience and has begun to develop integrated individual action planning within a careers self-referral structure, supplemented by regular individual and small group review sessions within the tutor group structure. A third school has introduced a form of individual action planning in Year 11. The progress of these initiatives is being tracked as part of the overall study, not least to ensure that successful approaches are communicated quickly across the consortium.

A major problem for Basingstoke is to find ways to change the deeply held cultural attitudes within the tightly knit communities of North Basingstoke. We propose to explore ways to raise the expectations of both the parents and their daughters. The schools have a role to play in this but they must first find strategies to bring the parents into the schools. Parents evenings, open evenings and presentations are often less well attended in this area, and prejudices here will have to be overcome. Strategies will be developed to make girls feel valued in school and to encourage them to make a full contribution to the academic life of the school. Several young women expressed regret that they were not pushed and they believed the school had low expectations of any one not in the top set. There is also a need to begin to change attitudes of the male. Linda Carr, Equal Opportunities Commission comments 'I don't think the education system is equipping young people to cope with life in the late 20th and 21st century. The national curriculum is interesting in this respect, because we see there the possibility of increasing girls' access to subjects like science and technology, but we don't see a complementary emphasis on personal and social education which would enable boys to perceive more realistically their role within the family and in employment'.

Research thus far has identified a complex cultural divide in an otherwise unified community supporting a high-tech, progressive conurbation. External factors such as the recession and its resulting unemployment have prompted young women to enter college access courses to obtain qualifications. This could be a major step forward for their daughters - and perhaps a positive outcome from an economic crisis.

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ATTITUDES TO EMPLOYMENT OF FEMALE AND MALE CIVIL ENGINEERING STUDENTS

Suzanne Wilkinson

But :
Ce document décrit les résultats d'un sondage national distribué aux élèves-ingénieures d'établissements d'enseignement supérieur du Royaume-Uni.

Thème :
Ce document tente de démontrer combien la courbe de l'emploi est différente entre les femmes et les hommes ingénieurs civils. Le sondage compare les résultats des élèves-ingénieures et élèves-ingénieurs civils et situent les principales différences dans les opinions et les attitudes à l'égard d'une carrière dans l'industrie de la construction. L'analyse des résultats produit un ensemble de conclusions intéressantes mettant l'accent sur le choix de carrière des ingénieures et ingénieurs professionnels. Ce document analyse ce qu'impliquent ces conclusions.

Méthodes de recherche :
On a eu recours à des méthodes de recherche qualitative et quantitative, dont des entrevues auprès d'étudiantes en génie civil et un questionnaire national adressé aux étudiantes et aux étudiants. Pour analyser les données, on a eu recours à un ensemble statistique sophistiqué.

Le document de recherche est disponible auprès de l'auteure.

ATTITUDES TO EMPLOYMENT OF FEMALE AND MALE CIVIL ENGINEERING STUDENTS

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Aim

The aim of this paper is to report on the findings of a national survey distributed in the United Kingdom to women civil engineering students in higher education establishments.

Focus

The paper argues that the pattern of employment of male and female civil engineers is significantly different. The survey compares the results of female and male student civil engineers and shows where there are significant differences in opinions and attitudes towards a career in the construction industry . The analysis of the results produce a set of interesting conclusions highlighting the career choice of professional engineers. The wider implications of these conclusions will be explored in the paper.

Research Methods

Both qualitative and quantative research methods were used. These included interviews with women civil engineering students plus a national questionnaire to male and female students. Analysis of the data was using a sophisticated statistics package .

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ELECTRONICS EDUCATION FOR WOMEN: EVOLVING NEW APPROACHES

Lynette Willoughby and Ruth Carter

Bien que l'électronique soit un domaine relativement nouveau, il retient toutes les constructions masculines de la structure, du contenu et de l'ethos de son prédécesseur immédiat, le génie électrique. Au Royaume-Uni, les ateliers de formation technologique destinés aux femmes ont relevé le défi d'offrir des cours d'introduction à l'électronique aux femmes sans emploi. Leur succès particulier a été relevé dans la sélection et la restructuration d'un matériel facile à comprendre et d'un environnement compatissant. Certains collèges ont suivi ce modèle en offrant aux femmes des cours d'introduction à l'électronique dans les cours de troisième niveau.

Comment peut-on adapter cette approche à la formation à distance? Un atelier auquel a assisté le personnel de centres de formation et de cours d'introduction pour les femmes a exploré la possibilité de modifier la culture masculine de la formation à distance en électronique. Ce document présente les idées et les stratégies pédagogiques qui sont ressorties de cet atelier.

ELECTRONICS EDUCATION FOR WOMEN: EVOLVING NEW APPROACHES

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ABSTRACT

Although electronics is a comparatively new field, it retains all the masculine constructions of structure, content and ethos of its immediate predecessor, electrical engineering. In the UK, women's technology training workshops have taken up the challenge of running introductory electronics courses for unemployed women. Their particular success has been in selecting and restructuring the material for presentation in a woman-friendly way in a sympathetic environment. Some colleges have followed their lead in providing women-only access courses to studying electronics in higher education.

How might this approach be adapted in distance education? A workshop attended by staff from women's training centres and women's access courses explored the potential for transforming the male culture of distance education in electronics. This paper presents the ideas and teaching strategies that emerged from the workshop.

INTRODUCTION

In 1992, the British Open University (OU), a distance teaching institution with a world reputation for excellence, had 80,000 undergraduates, 7,000 postgraduates and 39,000 students taking single courses of varying length. Of the 80,000 undergraduates, half were women, a higher proportion than in any other British university. However, it will come as no surprise to GASAT7 participants to find that the women students are not distributed evenly through all faculties. Predictably, there are far fewer women studying courses in Science, Mathematics and Technology than in Humanities, Social Science or Education.

In the Faculty of Technology, we have focused on improving the recruitment and support of women students and staff for a sustained period (Carter & Kirkup 1991). We are pleased that our foundation level (first year) course, *T102 Living With Technology*, now attracts 25-30% women students, but concerned that most of these women do not choose to continue to study

second and third level Technology Faculty courses. The picture is particularly disappointing in the more technical subject areas such as mechanical engineering and electronics, where only a handful of the students on each course are women.

Table 1

Students completing OU electronics courses in 1992

Course	*students*	*men*	*women*	*%women*
second level				
Analogue & Digital Electronics	851	830	21	2.47
Microprocessor Based Computers	1432	1300	132	9.22
Instrumentation	420	407	13	3.10
third level				
Digital Communications	569	550	19	3.34
Electronic Materials & Devices	115	112	3	2.61
Control Engineering	302	298	4	1.32

We knew that, in electronics, there was an established body of expertise on teaching women in some of the women's technology training workshops based in cities around Britain. In addition, a few colleges run access courses for women wishing to study electronics in higher education. Like the OU, both cater for students with no prior educational qualifications. Feeling that the low participation of women in OU electronics courses (illustrated in Table 1) needed further attention, we set up a workshop to explore the issues it raises.

THE WORKSHOP

The workshop, *Teaching Electronics To Women*, was held in November 1991 under the auspices of the Open University Women Into Science and Engineering (WISE) Research Group (WISE Research Group, 1991). The twenty four participants were equally divided between OU staff and representatives of nine of the women's technology training workshops and three of the colleges with special access courses. Amongst the OU staff were three male academics

from the Electronics Department, sympathetic to considering gender issues in electronics education and ready to advocate positive outcomes to their colleagues.

The event opened with a talk on the challenges the women's workshops face in teaching electronics to women, how they have been tackled and how the women students respond. Discussion groups then considered developing woman-friendly practice in distance education in electronics, using some pre-circulated OU material from the course *T202 Analogue & Digital Electronics* as a starting point. After lunch, small groups brain-stormed around the theme of "re-inventing electronics" and the day closed with a summary of some of the best ideas that had emerged during the workshop. A selection is discussed here.

STUDENTS PRIOR PERCEPTIONS

A major deterrent to studying electronics seems to be the perception that it is a "difficult subject". Is it inherently more difficult than other subjects that are perceived as "easy"? Another culturally based perception is that electronics, like its immediate predecessor, electrical engineering, is a field for men, not women. In Britain, engineering courses in general, and electronics courses in particular, are recruiting poorly. Men as well as women are alienated from the idea of studying these subjects.

Several different strategies have been tried over the past decade to overcome these prior perceptions. Most of these are based on a "come and try it" approach, emphasising that no prior knowledge or specialist skills are needed. They vary from short "taster" and "Insight" courses (EITB, 1991) to one year full time courses such as those offered in the women's workshops. Staff on some courses, in their efforts to attract women, have felt that even calling a course "electronics" will put women off and have avoided the term altogether by inventing alternative titles.

The experience of all these strategies, but of the women's workshops especially, has shown that

the key to overcoming students' prior perceptions is CONFIDENCE. Perhaps the greatest achievement of the workshops has been to give women confidence in what they have learnt and to validate what they are able to do at the end of their courses.

COURSES FOR WOMEN ONLY ?

One consequence of the masculine image of electronics is that advertising courses with the words "open to women and men" or "women are encouraged to apply" does not generate many extra women applicants. However, advertising women-only courses does produce a demand from women. Often such courses are also staffed by women, and the evidence is that women students really appreciate the supportive, woman-friendly atmosphere. In contrast, women on traditional courses are very sensitive about being singled out and identified as "special", which often happens either because their gender confers heightened visibility or when special support schemes for women are initiated. It is important for their identity as engineers to be accepted in their peer group and to be treated as ordinary members of the course (Carter & Kirkup 1990).

STAFF DEVELOPMENT AND AWARENESS

Getting women on to courses achieves little if they are then totally alienated by the ensuing experience. This may result from the content or structure of the course or because of the attitude of members of staff or other students (Hall & Sandler, 1982; Sandler & Hall, 1986). Although extreme sexism is rarely experienced by women students, alienation from a culture which gives women no legitimacy or credibility is commonly felt. Sexist jokes that male staff have developed over the years as an unconscious strategy for establishing rapport with male students is a clear example of a contributory factor. Staff teaching on traditional courses have, by definition, succeeded in the system and most accept it unquestioningly.

Institutional commitment to encourage more women on to courses is not sufficient to guarantee subsequent support for them while they are studying. Neither is theoretical commitment by

management that is not reflected in teaching practice. A staff development programme is essential to raise the awareness of all staff to issues of gender. It must suggest alternative, GENDER-INCLUSIVE approaches to teaching that do not distinguish between students on the basis of false gender stereotypes, but enable staff to build on the different contributions of all students. Most essential is that staff should eventually develop the skills of gender awareness for themselves, analysing problems as they arise and producing their own solutions.

PREPARATION

Traditional courses often assume or require certain levels of mathematics, physics and/or experience with equipment. Women (and many men) often do not have this. There are a number of possible approaches to bridging this gap:

1) to design preparatory courses, such as those offered by the women's workshops.

2) to have a foundation course at the higher education institution itself, so that the course is specifically geared to the requirements of the higher level course. One problem here can be funding and obtaining grants, though some limited solutions have been found. Other institutions have dismissed the possibility of such courses as they consider anything lower than degree level as the province of local colleges.

3) to have a weekend preparatory course, perhaps for women only, which is particularly appropriate if the material is clearly defined and mainly, say, to do with familiarity with equipment. Although funding for this can again present a problem, it is a very successful approach, especially in developing confidence (Swarbrick, 1986). Students gain from seeing themselves as part of a body of people with shared difficulties rather than as isolated individuals with individual problems.

4) the preparatory material could be covered in pre-despatched, multi-media, open learning materials. These can then be targeted at women and non-technical men and could include introducing the use of equipment.

5) to include the necessary preparatory material as part of any course itself, either as a short section at the beginning of the study period, as a subsidiary module running alongside the

course, or integrated into the course and introduced as necessary. In the latter case, it can be provided as subsidiary material that can be studied independently if required.

CONTENT OF COURSES

It is important for courses to obtain professional recognition and accreditation by the professional engineering institutions, the Institution of Electrical Engineers (IEE) in the case of electronics in the UK. The institutions therefore have considerable power over course content. They are extremely hierarchical and notoriously slow to change, often holding back innovation in teaching.

Current developments in engineering courses are aimed at broadening the focus of specialists to develop an awareness of the impact of their professional work. Many courses, partly driven by the desires, needs and perceptions of industry and partly by the falling interest in their traditional content, are including more social orientation e.g. Engineering and Management. It is thought that such courses will appeal to a wider range of potential students, including more women. This is very much in line with the experience and philosophy of the women's workshops in terms of what are perceived as more attractive courses for women. The trainers report that women want to put their knowledge in context rather than learning abstract theoretical material that seems to bear no relation to real life. It is quite remarkable that engineering subjects, including electronics, which one would have thought of as being essentially practical and related to their applications, can actually be perceived, and indeed taught, as completely abstract and theoretical.

The desirability of putting the subject in its context also drives the structure of the courses. Practical work needs to precede the theory so that students can relate to the theory more clearly and see the need for it and what it refers to. Doing the practical work builds up an interest in understanding the underlying theory.

The women's workshops, along with many traditional providers, are now concentrating more on project work. Projects can put the subject matter neatly in context, bring in a whole range of technical and non-technical skills and provide the opportunity for co-operative work (Kolmos, 1990). Group co-operation is important for women students who dislike the tradition of competitiveness that often pervades male-dominated courses. A pitfall of project work is the tendency for women and men to assume stereotyped gender roles in mixed groups.

An important feature of the women's workshops that other courses will be increasingly hard pressed to replicate is the personal attention that the trainees receive.

WHAT IS ELECTRONICS?

The is the starting point for more revolutionary change than that discussed so far. Attemps to answer this question pose two others: "What are electronics courses trying to achieve?" "What do electronics engineers NEED to know?" A short history has grown fixed habits and it often takes a great deal of courage to break away from the old moulds.

There is general agreement that courses need to cover a "foundation", but what this is and why it is necessary is elusive. A foundation enables people in the field to make common assumptions and reference back to a common background. Such assumptions are often misplaced. A certain common knowledge is useful for communicating, but few would agree on its definition. The ability to communicate with professional peers is more a matter of confidence than of detailed knowledge. There is increasing emphasis on the need for transferable skills in the professions. In traditional courses there is not room to develop all that has habitually been covered AND all the new subject areas AND these new skills.

Students have always made choices between certain subject specialisms after "covering the basics". The implication of this train of thought is that it should be perfectly "respectable" for the menu of choice to extend downwards to foundation level.

ON TIMELINESS

Discussion of all these issues, and the emergence of new directions for the teaching of electronics, raises the question of why we chose to target electronics as a subject for review, instead of, say, mechanical engineering. The answer has several strands.

First, the Electronics Department at the OU has been undertaking its own reflective review of courses and attempting to assess what it should be offering students from the mid 1990s to the millennium. There is a requirement to produce new courses and the time is ripe to reconsider teaching styles as well as content.

Second, people in other education and training institutions had developed different ways of teaching electronics to women and were willing and able to discuss new approaches with us. The women's technology training workshops were set up from the early 1980s in response to perceptions that there was a skills shortage in high technology industries. Because electronics and computing were seen as growth areas, jobs were thought to exist in industry and in academia which could be filled by women who had had newly created opportunities to acquire the skills in demand. Here was a chance for local authorities and the European Commission to earn credibility for their equal opportunities policies by funding serious training schemes that enabled women to take hold of non-traditional skills and to move from the poverty of unemployment into interesting work.

Third, the notion that women's talents will not otherwise contribute to the direction of technological development is now a legitimate argument in support of special education and training initiatives for women. The words "high technology" represent an icon of progress, in much the same way that "space exploration" became symbolic of progress in the 1960s. Bursts of technological innovation which catch the collective imagination of popular culture tend to be perceived as male territory, particularly when high levels of economic reward are available. Women are marginalised or fully excluded unless positive action is taken. For

example, few women were able to participate in the expansion in civil engineering in the nineteenth century.

CONCLUSION

From the point of view of feminist activists working in engineering education, it is quite clear that similar reviews of gender issues in the teaching of all technological subjects are long overdue. Many of the issues we discuss in this paper in relation to electronics apply equally to other fields. However, at this particular conjuncture, a combination of circumstances made it possible to open up the debate about electronics; we have taken advantage of that opportunity. There is still a long way to go to achieve a scenario where women constitute 50% of all engineers.

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FEMINIST CRITIQUES OF SCIENCE AND TECHNOLOGY IN ENGINEERING EDUCATIONS

Sylvia Benckert and Else-Marie Staberg

Dans ce document, nous traitons de l'importance d'introduire des critiques féministes du domaine des sciences et de la technologie dans les études de génie, et décrivons notre expérience d'une telle introduction. Nous avons organisé, sur une période de quatre ans, une série de séminaires et deux cours, un à l'intention des diplômées et diplômés et un à l'intention des étudiantes et étudiants au niveau du baccalauréat de l'Institute of Technology de Lulea (Suède). Nous avons décrit notre plan d'action, la façon dont nous avons rehaussé les compétences et le contenu de nos cours. Nous avons étudié les résultats de notre travail, tels qu'ils sont à nos yeux et aux yeux des étudiantes et étudiants. Nous estimons que l'introduction de tels cours est une façon adéquate de diffuser les connaissances féministes dans le monde du génie.

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Feminist Critiques of Science and Technology in Engineering Educations

Challenges and Possibilities

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Abstract
In our paper we argue for the importance of introducing feminist critiques of science and technology in engineering education and describe our experience of such an introduction. During a period of four years we have organized one serie of seminars and two courses, one for graduate and one for undergraduate students at the Institute of Technology in Luleå. We describe our course of action, how we built up competence, and the contents of our courses. We reflect upon the result of our work as seen by us and the students. It is our belief that introducing such courses is one possibility to make feminist knowledge known in the engineering world.

Introduction

The feminist critiques of science and technology are well known today only in a fairly small group of people. Texts by Sandra Harding, Ruth Bleier, Evelyn Fox Keller, Joan Rotschild and others are read and discussed. But we have to widen the group. One possibility is to implement this knowledge into the education of scientists and engineers. However, this is a real challenge since scientists and engineers in general are completely unaware, or worse, quite hostile to these perspectives. Still, there are several reasons for trying.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

1. Women's contributions to both science and technology have by and large been left out of the history of science and technology and even if we are women scientists or engineers, we do not know our predessors. We do not even know that they have existed. It is essential to recover the women scientists hidden from history. This knowledge has to be spread to science and engineering students.

2. It is of the utmost importance to discuss biological theories because such ideas are quite spread among natural scientists. Students should know that scientific ideas about women have been used historically to exclude women from for example higher education. These biological theories also show very clearly the influence of culture and values on science.

3. Notions of femininity and masculinity are deeply rooted as well as the notion of the masculinity of both science and technology. Judy Wajcman (1991) discusses the masculine culture of technology in her book *Feminism confronts technology*. She writes: "Central to the social construction of the engineer is the polarity between science and sensuality, the hard and the soft, things and people. ... Engineering seems to be the very epitome of cool reason, the antithesis of feeling." Masculinity can be defined in different ways. It is expressed both in terms of physical strength and aggression and in terms of analytical power, but it seems always to construct women as illsuited for technology and for science. Engineering cuts across the boundaries between physical and intellectual work while science is purely analytical and rational. This masculine culture of science and technology has to be examined and discussed.

We think it is very important for science and engineering students to be confronted with these ideas. Women students can hopefully aquire strength out of such a confrontation.

4. We tend to think about technology in terms of industrial machinery and cars, ignoring other technologies that effect most aspects of everyday life. The very definition of technology, in other words, has a male bias. This emphasis on technologies dominated by men in turn diminishes the significance of women´s technologies, such as cooking and sewing. This nexus between masculinity and technology contributes to the idea that women are not suited for work or studies in the field of technology.

5. Technology is a significant factor in shaping society today and it is therefore of the utmost importance to scrutinize its effects on social life and culture and especially on gender systems. We think that discussions of the influences of technology on society, including its effects on the gender division of labour and on gender symbolism, should be part of every engineering education, but that it is most essential for women engineering students.

The two of us were asked by Women´s Studies Centre in Luleå to assist them with courses in "Women, science and technology" and then tried to implement the ideas mentioned above. We decided to build up the courses and at the same time our own competence step by step. For some years we had followed the debate about feminism and science and also written some articles in the field, but had only superficially studied feminist perspectives on technology.

Three steps towards the future

The small steps we describe took place at the Institute of Technology in Luleå, a town situated in Northern Sweden. The first step was a series of seminars to which we invited the members of the Women´s Studies Centre and other interested women. The series,

given in 1989, was called *Visions and Revisions*. Although the different themes were introduced, we expected the participants to read selected texts and actively to partake in the seminars.

The second step, in 1990, was a graduate course. This course, *Women, science* and *technology* naturally had to be approved of by the faculty. The Centre succeeded with the lobbying thanks to an energetic director and to a couple of members of the Forum with strong positions at the faculty. We chose to start formal courses at graduate level hoping to attract research students who later could become teachers on undergraduate courses. The course credits, three points, which altogether equals three weeks´ work for the students, was to be included in the students' doctoral study program.

The third step, which of course also had to be approved of by the faculty, was to introduce an optional course of four points (four weeks' work) in the engineering education. Other options were e g foreign languages and social studies. The first of these courses, called *Feminist perspectives on science and technology* took place during the spring term in 1991.

The series of seminars attracted women from a wide variety of professions. There were teachers from different levels, a medical doctor, a dentist, administrators, artists, an architect.... Some of them had taken other women's studies courses, but for quite a few this kind of knowledge was a novelty. The course at graduate level brought together fourteen women from different doctoral programs. The first undergraduate course was followed by twelve students of whom two were male, the second course by twelve women and three men. The second year, when the course had become known, several chose the course after

having heard positive reactions from the first course. Some of these students had wanted to take the course the first time, but did not dare because of the reactions from other students.

The contents of the courses

The Vision and Revision - serie included, as a background, seminars on the gender division of labour in science and technology, biological theories about women and gender symbolism and the masculinity of science. Then we discussed technology assessment, women and computers, women and economy, reproductive technology and the built environment. For some of these seminars we invited guestspeakers and for some we discussed the theme with some articles as starting points. We could often use articles from the Swedish Women´s Studies Journal *Kvinnovetenskaplig tidskrift*. Corlann Gee Bush´s article *Women and the assessment of technology: to think, to be, to unthink, to free* (1983) proved to be very valuable in introducing discussions of technology assessment. The serie of seminars was completed with our reading of feminist science fiction which is a good way to contemplate the feminist critique of technology.

The content of the graduate course *Women, science and technology* was much the same as in the seminars but on a deeper level. It also included an introduction to feminist theory. The literature was naturally more extensive for the students than for the participants of the seminars and the students also wrote a paper. Their final papers concerned e g feminist utopias, girls and mathematics, the gender system at their own university and women's experiences at the workplace.

Before starting the optional course *Feminist perspective on science and technology* we had to decide what contents were appropriate for these students. We expected these

students to be less conscious of feminist perspectives than the participants in the seminars and the graduate students, and so it appeared to be. The history of women in science proved to be a good starting point, easy to get engaged in. We then treated most of the themes from the seminars and the graduate course but with less extensive literature. The part including the gender division of labour and the connection between this division and technology was extended in this course. A lecturer from the Department of Work Studies taught and planned this section. At the second one of the undergraduate courses parts of the teaching was done also by others, among them two young research students who took part in the course at graduate level. The studies were finished by a small project work and a paper. The project work was a small investigation or literature studies.

Reflections

The courses differ from most other courses in engineering studies. There are no given truths. Instead the students have to read texts treating problems from differents points of view and are expected to take a standpoint of their own. They are confronted with new ways of looking at society and have to reflect over gender structures and symbolisms they have not been aware of.

The reading of the texts sometimes caused problems. Reading social science texts asks for other strategies than the students were used to. Engineering students are used to texts with a lot of facts. They are not familiar with arguing texts, to which you yourself have to form an opinion. Some students found it difficult, especially when the texts were in English.

The overall reaction was positive towards both content and form. The students appreciated being in an environment where teachers and students listened to each other. They were used to listen silently to lecturers and appreciated that all students were given opportunity to speak. There were problems with this, especially in the first undergraduate course where the two men tended to dominate the interactions in the group in a way that had no relation to their insights or knowledge. If men are invited to courses like this, these problems have to be dealt with.

Can giving optional courses for less than twenty people a year really be looked upon as a success, that is a possibility to introduce feminist knowledge? We think so bearing in mind the challenge which is the strong resistence and scepticism towards a feminist perspective on gender, science and technology, expressed also at this university. And even if the actual participants were few, they came from different programs and spread the ideas to other students.

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GENDER, PROJECT WORK AND THE META-PERSPECTIVES OF SCIENCE

Karin Beyer

On aborde dans ce document les aspects de l'apprentissage des rôles féminis et masculins et des sciences en soulignant la nécessité, pour les étudiantes et étudiants, de s'engager et d'assumer les responsabilités de leur apprentissage. Les différences entre les sexes dans les styles et conditions d'apprentissage rendent l'atteinte de l'objectif «d'enseignement des sciences sans parti pris contre l'autre sexe» impossible. Il est à espérer que le fait que les différences entre les sexes soient reconnues conduise à un enseignement des sciences sans distinction des sexes. Nous parlons également dans ce document d'un modèle danois d'enseignement universitaire axé sur les problèmes et fondé sur l'apprentissage coopératif et un degré élevé de direction et de contrôle des participantes et participants.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

GENDER, PROJECT WORK AND THE META-PERSPECTIVES OF SCIENCE

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Aspects of gender and science learning are discussed with a focus on the necessity of students' *engagement in and responsibility for* their learning. Gender differences in learning style and conditions for positive engagement make it impossible to obtain a "gender neutral science education". Hopefully, consiousnes of gender differences leads to a gender-inclusive science education. – A realized Danish model of problem-oriented and project-organized university education based on cooperative learning and a high degree of participants' direction and control is outlined and discussed in the gender perspective.

INTRODUCTION

Gender and science learning are discussed with a focus on students' *engagement and responsibility*, which are crucial in any educational setting and ought to be the center of interest for educators (Tytler, 1992). While many schools and universities include in their curriculum some kind of project work, in which the students have a greater responsibility – and consequently show a greater engagement – than in usual courses, very few educations devote a major part of the study time to projects. I will present the basic ideas and some experiences from a university which is fundamentally project-organized. I will discuss the ideals and some dilemmas in the light of students' involvement and responsibility, and the gender perspective. This model not only provides students with process skills and enhanced knowledge about the learning processes; it also implies another curriculum, that includes knowledge about the character of the different sciences, their applications, development and role in society i.e. the meta-perspectives of the sciences.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque International GASAT 7, Canada, 1993

MOTIVATION, ENGAGEMENT AND RESPONSIBILITY

It is generally agreed that the student's interests and motivation is crucial to the outcome of learning processes, yet even in psychology different schools or traditions use the term differently. In daily teacher-talk motivation is used (depending on the context) for interest, motives, curiosity, engagement or commitment. Here I want to discuss the aspect of *conation: the will to learn, the drive or commitment*, which is closely related to the acceptance of responsibility for one's own learning. Several authors have emphasized the significance of conations, but seldom are these aspects developed further to allow integration of gender-based and other differences in learning style in a comprehensive theory of learning (Beyer,1991).

Gender differences in learning style and engagement.

In the Danish research project on "The Gender-Polarizing Effect of Physics Education" we found gender differences in students' involvement and outcome in physics in upper secondary school (gymnasium). We formulated the hypothesis that girls and boys - through socialization and education - develop different *learning styles* and we found that student's *self-confidence* (in the specific subject area) and *attributional style* are factors having an important influence on learning (Beyer 1991, Beyer & Reich 1987, Vedelsby 1987, Beyer et al. 1988). We found support for this hypothesis in several theories, among them the theory of Autonomous Learning Behavior of Fennema and Peterson (1985) which stresses the significance of students belief system, their responsibility and persistence in learning or problem solving.

As has often been reported in GASAT contributions, gender differences occur in students' rating of science topics according to their interests. Girls more than boys favour topics related to human beings, the environment or ethics questions. Therefore it is important to present the subject-matter in a context that demonstrates its relevance in a wider perspective. *But* choosing topics that are perceived by students as interesting and relevant is no guarantee that students actively involve themselves in the activities, take on the responsibility for their learning processes - and persist

when things become difficult. Motivation in the weak sense of interest is not enough to establish the needed *drive or committment!*

A gender neutral science education?

A number of factors including classroom climate, personal relations, the feeling of control, the kind of task given (difficult enough to be a challenge, but not so difficult that students fear a failure and block up) must combine constructively. These factors influence the learning situation of boys as well as of girls, but I will postulate that *the positive interplay between the wide spectrum of affective and cognitive factors is more crucial to girls' involvement and learning than to that of most boys* (Beyer,1992a), and therefore a "gender neutral" science education does not exist. To a certain degree, boys and girls will always tend to perceive teaching situations and topics differently. If educators and teachers are conscious of these gender differences we can hope to develop a gender fair or even *a gender-inclusive science education!!*

Gender and the comprehensive theory of Baird et al.

Baird et al. stress the complexity of learning processes and their theoretical basis seems to be valuable for inclusion af the gender perspective, although the authors do not include gender questions themselves (Beyer 1992b). Baird et al. (1991a,b) stress the importance of student's reflection on learning processes and outcome leading to enhanced *metacognition*. Such conscious reflections are supported by *collaboration*.

Metacognition is related to responsibility of learning, and training has three aspects: increasing students' knowledge of what learning is and how it works; enhancing students' awareness of learning progress and outcome; improving students' control of learning through more purposeful decision-making.

Students' must perceive a true *challenge*, and this again presupposes a balance between cognitive and affective factors. Self-confidence, the climate of teaching and personal relations in the class are important factors, and so are the kind and amount of work required, its perceived relevance, the possibilities to get personally involved in and have control of learning and assessment. All significant factors that are often

emphasized in relation to gender and science education. The student's responsibility is, again, of great importance.

PROJECT-ORGANIZED STUDIES AT ROSKILDE UNIVERSITY.

Many of the above criteria for improved science education are met by project-organized studies. Since its start in 1972, Roskilde University has functioned on the principles of problem-orientation and project-organization. From the first day at the university, the students work in project groups with a high degree of participants' direction and control. Project work occupies at least 50% of the study time and is complemented by traditional courses. Typically, the students do a project and write up a report each semester. Projects also play an important role in assessment and examination.

All students are required to take a two year basic studies programme in either science, humanities or social science, followed by specialized degree programmes focussing on one or two subjects. The specialized programmes (e.g. for Master Degrees) are also project-organized.

The Danish model of project work

The Danish concept of project work is closely related to a line of educational thinking and philosophy, identified as "experiental learning", which is similar to, but not the same as, learning by doing, or learning by experience. "Experiental learning" deals with learning processes as integrated aspects of the individual's total development, influenced by personal history, life conditions, situation, interests, motivation, etc. A central issue in project work is therefore the student's participation in and responsibility for all important decisions in the process (Illeris, 1992).

Methodologically, project work is based on three fundamental theoretical principles: *Problem orientation* indicates – in contrast to the traditional subject or discipline orientation – that the starting point for the work is a problem or a set of problems.

Participant direction indicates that the studies should be directed jointly by students and tutors. While all participants are equal, they have different functions and responsibilities. This makes the role of the teacher particularly demanding. He or she has a specific professional responsibility, but must act in agreement with the students and has no means of forcing them to accept his or her suggestions or standpoints. *Exemplarity* indicates that the problems and content material chosen should be representative of a larger and essential area of reality. Through deep and serious work on a genuine problem of personal interest the underlying structures of the problem area are uncovered, and this enables students to generalize their insight into new contexts (Illeris, 1992).

The theoretical basis of the project work at RUC was developed in relation to social science and humanities, inspired by Negt's theory (Negt 1971). Most of the principles have been transferred to science as well. But due to the nature of (natural) science it is not possible to choose problems for project work, that are "exemplary" in the sense of Negt and Illeris. The sciences: mathematics, physics, chemistry, biology and geography differ in objects, methods and general character, and they differ in position in the world and function in society.

Case-studies and meta-perspectives

Educations that lead to careers in a certain field of praxis, e.g. medicine, law, construction engineering, can benefit from projects on cases from this praxis-field. While such examples are relevant in interdisciplinary science education leading to a spectrum of different carreers as well, there is a danger, that after a number of such projects the student is left with a rather kaleidoscopic collection of bits of specific knowledge, from which it is very difficult to create generalized knowledge. Therefore general questions of the nature and function of the different sciences and their similarities and differences, are set on the agenda for the introductory Basic Study Programme of Science. A system of "semester-themes" have been formulated as frames for the project work each semester, as shown in the box below. Projects in the Basic Study Programme of Science (NAT-BAS) cannot be four variations of the

same kind of project, but rather representative projects involving different sciences, as well as asking different questions or revealing different aspects of the sciences and their nature, applications, development and role in society. These *meta-perspectives of science* lead to questions "about the sciences", not questions "inside a science". So theory of science and technology and history of science might be involved as well as theories of science education, discussion of science and technology in the media. In different ways, science and technology are shown to be human activities. At all stages the group must indicate how their problem and work satisfies the actual semester-theme. Students therefore have to reflect on these meta-perspectives.

THE SEMESTER-THEMES FOR PROJECT WORK IN NAT-BAS/RUC:

1. Semester: **SCIENCE IN SOCIETY:** The project work must illuminate the application of science in the interplay of nature, technology and society, and in the regulation of this interplay and its components.

2. Semester: **MODELS, THEORIES AND EXPERIMENTS:** The project work must illuminate the role of theories and models, especially mathematical, in the sciences. The interaction between models, experiments and theories in science and the structure of such theories should to be demonstrated.

3. Semester: **COMMUNICATION OF THE SCIENCES AND THEIR APPLICATIONS:** The project work must illuminate at least one of the following points: 1) the significance of communicating problem areas in which science plays a serious role, 2) problems in relation to the communication of science, 3) the status of science as a theory of knowledge and a shaper of consciousness. – The Danish word for "communication" includes education, as well as dissemination of science knowledge through science centers, TV and other mass medias.

4. Semester: **OPTIONAL:** The project work must include scientific theories and methods.

Some dilemmas.

Students choose problems which they find interesting and relevant. Especially in the introductory programme, NAT-BAS, students often choose problems they have encountered on TV or in other media, e.g. the greenhouse effect. Of course they do not posess all the knowledge needed to tackle such problems, but they *can* do something, and they come to know much more of what kind of knowledge is involved and what role is played by different experts in the problem and in the puplic political debate. Not a poor background for further independent studies!

Although students (in the 2. – 4. semester) try to include the teachers' competence in their considerations, it is sometimes the case that the teacher has limited knowledge in the field of the project – and the teacher's true competence is not fully utilized. In the specialized degree programmes, the interests and qualifications of teachers play a more significant role in the choice of projects. In both cases, teachers can offer general project and science experience, knowledge about relevant literature and assistance of collegues. *Giving students a major part of responsibility leaves less possibilities of control for the teacher. The job of the teacher is to guide and support the group and to challenge them during their work.* The teacher also gives advice in relation to the collaboration process and guide and support individual students.

Despite these and other dilemmas and problems, great advantages follow from the problem-oriented, project-organized studies. First of all, the authentic nature of the problem and the fact that the students have chosen it themselves, and further struggled to develop, reformulate and focus it, requires a very high degree of engagement and hard work. It is really the group's project, and the saying: *"ownership breeds success!"* is appropriate! Project work is not only a way to learn process skills and cooperative learning (and work); it can also lead to higher cognitive abilities in valuation and critical analysis. *It is important to "learn HOW to learn", but the independent and autonomous learner must also "learn WHAT to learn – and WHY"!*

PROJECT WORK AND THE GENDER PERSPECTIVE.

Research on gender and science education has shown that female students more than male students find it important that the educational activity is relevant in a social context, that students participate in choice of content and activities, and that the quality of cooperation and the work process as well as the product is (e)valuated. Female students want to be involved and to apply many of their personalities and competences. Project work according to the described model, fulfills most of these requirements, by compelling students to take initiative and to express them selves in small as well as larger groups. Female students are active and very responsible under these conditions. One of the reasons might be that collaboration in project groups with positive inter personal relations enhances students' self-confidence and counteracts tendencies of learned helplessness.

At NAT-BAS, Roskilde University, about 50% of the students are females and the proportion of new female students in the specialized programmes in physics is 33% and in mathematics as high as 53% (Beyer 1992b). This is higher than female percentages at other Danish universities, but comparison between the different universities should be undertaken with care, as they are not necessarily attracting the same type of students.

Students who are committed to study physics or mathematics from high school (gymnasium) will generally go to one of the traditional universities, where the line of specialization is chosen from the first day. Many women and men have not yet decided which subjects to choose, or are more generally motivated for "something with science in society". These students might very well be attracted by the project-organized interdisciplinary programme of Roskilde University. Since specialized programmes in physics and mathematics include projects, some of them dealing with the meta-perspectives, this alternative university might be *"stalking the second tier"*, as Sheila Tobias (1990) has formulated it.

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L'INTÉGRATION DES ÉTUDIANTES À LA FACULTÉ DES SCIENCES ET DE GÉNIE DE L'UNIVERSITÉ LAVAL : BILAN ET PERSPECTIVE

Louis Foy

In spite of the progress realized within the last decade in Canada, the proportion of women in the fields of science and engineering remains below that of men, especially in engineering programs. Recent research conducted at the Science and Engineering School of Laval University has shown that women experience motivation and un-motivation factors to pursuing studies in the study program in a different manner. This is what we have coined "specificity of women".

The process experienced at the School is described in this article where the two assumptions -- a change in attitude in our midst and a necessary commitment by men to such change -- are essential goals for achieving a genuine integration of women within the scientific world.

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L'INTÉGRATION DES ÉTUDIANTES À LA FACULTÉ DES SCIENCES ET DE GÉNIE DE L'UNIVERSITÉ LAVAL : BILAN ET PERSPECTIVE

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RÉSUMÉ

Malgré les progrès réalisés au cours de la dernière décennie au Canada, la représentation des femmes en sciences et en génie reste en deçà de celle des hommes, particulièrement dans les programmes de génie. Les travaux menés à la Faculté des sciences et de génie de l'Université Laval ont révélé que les femmes vivent différemment les facteurs de motivation et de démotivation à la poursuite des études dans leur programme d'étude. C'est ce que nous avons nommé la spécificité des filles.

Le processus vécu à la Faculté est décrit dans cet article où les deux postulats — le changement de mentalité du milieu et la participation nécessaire des hommes à cette évolution — constituent des objectifs essentiels à l'atteinte d'une véritable intégration des femmes dans le milieu scientifique.

INTRODUCTION

À l'ère de la mondialisation des marchés, le Canada se doit d'être compétitif au plan du développement scientifique. Parmi les pays industrialisés, le Canada compte peu d'ingénieurs et de scientifiques, soit 25 pour 10 000 personnes actives contre 47 en Allemagne, 67 aux États-Unis et 69 au Japon. De plus, le recrutement d'étudiants en sciences et en génie devra se faire à partir du réservoir de la clientèle étudiante pré-universitaire que l'on prévoit décroissante.

On constate aussi la faible représentation des femmes dans le domaine des sciences et du génie, là où elles constituent moins de 5% des ingénieurs canadiens. Étant donné les conditions socio-économiques défavorables affectant le marché du travail et que vivent particulièrement les femmes, les carrières scientifiques représentent un secteur prometteur pour elles et pour le pays.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

Se pose aussi le problème particulier de l'accès à l'égalité en sciences et en génie. Le nombre insuffisant de femmes ingénieures ou scientifiques ne permet pas l'implantation rapide des politiques d'équité et d'égalité en emploi dans ce secteur. Les femmes étant moins présentes au niveau du doctorat qu'aux études de premier cycle, le recrutement de jeunes professeures et professionnelles demeure difficile et la parité n'est pas envisageable à court terme.

PROBLÈMES IDENTIFIÉS

La préoccupation de l'Université Laval face à la sous-représentation des filles au sein des programmes de sa Faculté des sciences et de génie n'est pas nouvelle. En 1987, une conjoncture favorable à l'Université Laval et plus particulièrement à la Faculté des sciences et de génie a permis la naissance du projet de recrutement et d'intégration des filles, qui se voulait un moyen susceptible d'apporter une contribution valable à cet effort collectif. Une première analyse de la situation réalisée dans le cadre du projet a mis en évidence quatre principaux problèmes rencontrés par les filles dans leur démarche d'insertion socio-professionnelle et qui sont apparus déterminants.

Il a été réalisé que les jeunes filles en âge d'orienter leur carrière souffrent d'un manque d'information juste et exempte de stéréotypes. Elles ont peine à réaliser que les carrières scientifiques contribuent au développement technologique et que de bonnes conditions de travail sont habituellement associées à ces emplois. Elles croient qu'il faut un talent exceptionnel, que les valeurs humanitaires et les contacts humains sont absents et que ces carrières impliquent un travail fort exigeant physiquement. Cette conception naît sans doute de la rareté de modèles attrayants et accessibles pour les jeunes filles. Cette absence s'explique par la persistance des préjugés sur le rôle et le statut des femmes dans la société et la résistance causée par la crainte de la féminisation des professions. Ces facteurs ont pour conséquence un support moins soutenu des familles et des milieux scolaires envers les jeunes filles enclines à des professions réservées traditionnellement aux hommes.

La rareté de modèles féminins reconnus entretient aussi certains préjugés ayant trait à la difficulté pour une femme de concilier la carrière avec ce type de profession. Les exigences physiques de travail et la féminité des femmes scientifiques et ingénieures leur paraissent inconciliables.

Les difficultés d'intégration des filles, dans des programmes d'étude où elles sont encore largement minoritaires, sont problématiques. Ces difficultés s'expriment par un pourcentage d'abandon un peu plus élevé que celui des garçons, une solidarité féminine et un sentiment d'appartenance moins développés ainsi que des attitudes sexistes à leur endroit.

Enfin, les diplômées font face à des particularités qui entourent leur intégration au marché du travail et l'évolution de leur carrière. Elles se heurtent parfois à des préjugés tenaces de la part de leurs confrères, à de la discrimination ou du harcèlement sexuel et à une évolution de carrière qui limite leur accès aux postes supérieurs, notamment à cause des contraintes reliées à la maternité.

FACTEURS DE MOTIVATION ET DE DÉMOTIVATION

C'est suite à ce portrait de la situation que la Faculté a mis de l'avant des actions variées et concertées dans le but d'inciter un plus grand nombre de filles à s'inscrire à des programmes traditionnellement réservés aux hommes, d'améliorer leur qualité de vie à la Faculté et de réduire le taux d'abandon. On a mis l'accent sur l'accueil et l'information professionnelle, la collaboration avec les associations étudiantes et autres instances universitaires en plus de mieux articuler les contacts avec les professeurs de sciences et les conseillers en orientation des collèges.

Parallèlement, il fallait bien connaître la perception qu'ont les étudiantes et les étudiants de la réalité avec laquelle ils doivent composer. C'est dans cette optique qu'a été réalisée l'analyse des facteurs de motivation et de démotivation à la poursuite des études dans les programmes de la Faculté. L'étude visait à identifier d'une part les facteurs de motivation qui peuvent influencer le recrutement et la poursuite des études et d'autre part les facteurs de démotivation dont peuvent dépendre le rendement scolaire et l'abandon d'un programme.

La cueillette des données s'est faite à partir de la technique du groupe nominal. Cette technique a été choisie parce qu'elle permet à un groupe donné de s'exprimer en subissant le minimum de contraintes ou de pressions de la part des membres du groupe. Les programmes ciblés ont été génie chimique, génie électrique, actuariat, génie mécanique, génie civil et biologie.

Globalement, et suite à l'analyse statistique des données, on constate que les filles et les garçons de ces divers programmes ont identifié les mêmes facteurs de motivation. Ces facteurs sont reliés à la notion de récompense professionnelle, c'est-à-dire les bonnes perspectives d'emploi et les salaires intéressants, l'intérêt pour la matière et le défi que représentent des études scientifiques. Il en va de même pour les facteurs de démotivation que les garçons et les filles ont identifiés de façon semblable à la notion d'épreuve à traverser, c'est-à-dire à l'exigence du programme, à la lourdeur de la tâche et aux lacunes dans l'organisation, l'approche et les méthodes pédagogiques.

SPÉCIFICITÉ DES FILLES

Bien qu'à première vue il se dégage une similarité dans l'identification des facteurs de motivation et de démotivation pour les garçons et les filles, un questionnement plus approfondi des résultats a mis en évidence le fait que les filles ne vivent pas les choses de la même façon que les garçons. Deux éléments semblent principalement en cause dans la compréhension de cette différence.

Tout d'abord, les filles envisagent globalement la réalité de manière à ce que la considération de l'être humain et l'importance de la qualité de vie soient nécessairement présentes, ce qui influence leur façon d'appréhender les situations et les problèmes. D'autre part, elles ont aussi des caractéristiques qui leur sont particulières. Elles sont notamment perfectionnistes et performantes, ce qui entraîne une plus grande difficulté à composer avec une grande quantité de travail. Il arrive qu'elles se sentent alors moins compétentes parce qu'incapables de tout apprendre. Elles ont parfois tendance à faire une équation entre leur valeur personnelle et la note qu'elles reçoivent. Elles analysent leurs résultats scolaires sur une échelle absolue plutôt que relative au reste de la classe et sont donc plus affectées par des basses notes.

Elles fonctionnent mieux dans un climat de collaboration que de compétition, fait observé dans d'autres études sur le sujet. Elles ont plus de difficultés avec certains procédés pédagogiques utilisés, particulièrement en contexte de processus d'élimination dans certains programmes. Elles accordent plus d'importance au support de leur entourage et sont plus vulnérables aux mesures persuasives ou dissuasives dont elles sont l'objet.

Elles sont animées par une motivation de type intrinsèque plutôt qu'extrinsèque, donc plus motivées par le désir d'apprendre et l'accomplissement plutôt que par des ambitions de carrière, le prestige, l'argent. Elles ont plus de difficultés à avoir une image professionnelle spécifique d'elles-mêmes à cause du manque de modèles. Elles ont tendance à percevoir les études comme une fin plutôt qu'un moyen pour atteindre leurs objectifs, elles accordent plus d'importance à ce qui se passe à l'Université, elles réagissent plus au climat. Elles accordent plus d'importance à la vie affective et sociale et elles ont des préoccupations sociales et humanitaires importantes. Elles sont généralement plus affectées par le manque de temps et plus inquiètes par la conciliation de leurs divers rôles à plus long terme. Elles sont aussi souvent déçues par la réalité scientifique qu'elles découvrent et qui n'est pas de nature à alimenter leurs idéaux. Cela les force aussi à être plus créatives et à rechercher des débouchés professionnels différents.

VERS NOS POSTULATS

Toutes ces caractéristiques contribuent à ce que nous appelons «la spécificité des filles» par rapport aux garçons. Caractérisées par cette spécificité, les filles doivent cependant s'intégrer dans un milieu dont les règles du jeu sont masculines, c'est-à-dire pensées par et pour des hommes, uniques occupants de ce territoire pendant longtemps. Elles doivent composer avec des règles qui reposent sur l'excellence, la hiérarchie, le partitionnement, le pouvoir et le contrôle, dans un contexte pédagogique compétitif et qui ne tient pas toujours compte de l'expérience des filles.

Cette spécificité conditionne de plus les filles dans leur façon de composer avec le métier d'étudiante, de s'adapter à l'environnement et d'envisager leur avenir professionnel. En bref, cela signifie que les filles ont les mêmes objectifs à atteindre, les mêmes obstacles à surmonter que les garçons mais, pour y parvenir, elles doivent nager dans des eaux qui ne sont pas nécessairement à la bonne température pour elles.

En conséquence, seules les plus fortes arrivent en bout de course intactes et épanouies. Les autres renoncent à une partie de leur identité pour s'adapter ou encore elles restent sans s'intégrer réellement, demeurant présentes sans l'être vraiment. D'autres s'abandonnent en ayant quelque part l'impression qu'elles avaient fait un choix qui leur convenait, ayant plutôt décroché du milieu que de la discipline.

Une nécessité découle de la reconnaissance de cette spécificité : si le milieu scientifique et technologique veut intégrer les filles, il doit les accepter non seulement quantitativement mais surtout qualitativement, c'est-à-dire dans le respect de leur spécificité propre

En clair, cela signifie qu'un milieu qui intègre bien ses étudiantes est un milieu qui leur fournit les conditions pour qu'elles puissent réussir le mieux possible à accomplir leur métier d'étudiante, faire vraiment ce pour quoi elles se sont inscrites à l'université. C'est à ce prix qu'elles pourront développer un sentiment de compétence personnelle et professionnelle qui leur permettra soit d'accéder aux études de 2e et 3e cycles soit de connaître une insertion réussie sur le marché du travail.

Cette conception de l'intégration de la clientèle étudiante féminine suppose évidemment qu'on priorise, parmi les conditions favorables à offrir, celles qui sont liées à l'organisation, aux approches et aux méthodes pédagogiques en mettant l'accent sur l'élément fondamental en pédagogie, c'est-à-dire la relation enseignant-enseignée.

Elle implique aussi qu'il y ait une évolution réelle du milieu dans le sens d'une ouverture de plus en plus grande à reconnaître la spécificité des filles et à en accepter les conséquences. Parmi ces conséquences, on retrouve l'enrichissement du milieu par l'apport spécifique des filles, l'augmentation du recrutement par la venue de filles «ordinaires» et l'amélioration de la persistance des étudiantes et des étudiants.

Il faut aussi que le milieu prenne en charge cette évolution, c'est-à-dire que toutes les instances concernées se sentent impliquées et responsables des changements nécessaires. La collaboration des hommes du milieu est nécessaire et souhaitable, et ceux-ci ont tout à gagner dans ce changement de mentalité.

EN PERSPECTIVE

Un changement de mentalité comme celui proposé ne se réalise pas en un jour. Un tel changement touche la qualité de l'intégration non seulement de la clientèle étudiante féminine, mais aussi celle des autres clientèles comme celles des étudiants étrangers, handicapés ou provenant de régions éloignées. C'est dans cette optique que la Faculté des sciences et de génie a récemment créé le comité d'intégration de la clientèle étudiante, qui a

pour objectif une meilleure intégration de toutes les clientèles étudiantes, bien que celle des femmes reste prioritaire. Le comité compte atteindre cet objectif en travaillant à l'amélioration de la qualité de vie à la Faculté, perçue à la fois comme milieu d'étude et de vie.

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OPENING SCIENCE AND TECHNOLOGY

Barbara Hodgson

Au cours des vingt dernières années, l'Open University, d'Angleterre, une université qui offre un enseignement à distance aux étudiantes et étudiants adultes, a recruté un grand nombre de femmes, et plus particulièrement des femmes qui ne possédaient aucune qualification officielle, dans des programmes d'études de sciences et de technologie. Nous parlerons brièvement des stratégies employées.

Bien que nous puissions être fiers des résultats atteints en matière de recrutement, la question de rétention est une autre paire de manches. Beaucoup de femmes s'inscrivent à l'université pour prendre des cours de sciences ou de technologie de base, mais abandonnent leurs études avant d'avoir obtenu un diplôme en sciences ou en technologie. Est-ce que les femmes ne tiennent pas à devenir des travailleuses scientifiques ou est-ce qu'elles ne tiennent tout simplement pas à suivre le type de cours offerts par l'université?

Ce document tente d'établir la raison pour laquelle les cours actuels n'attirent pas les femmes; il parle des cours mis en oeuvre actuellement qui risquent de mieux répondre aux besoins des femmes; il évalue les mesures d'intervention visant à rendre le programme d'études plus accessible aux femmes; et il examine le succès des autres mesures de soutien destinées aux femmes qui étudient les sciences et la technologie.

Le document de recherche est disponible auprès de l'auteure.

OPENING SCIENCE AND TECHNOLOGY

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Over the past twenty years the Open University in Britain, a university which teaches adult students at a distance, has been successful in recruiting large numbers of women, especially those with no formal qualifications, into degree level study of science and technology. Ways in which this has been done will be briefly reviewed.

While we can be proud of our recruitment achievements, the retention record is another matter. Many women come into the University studying science or technology foundation courses but do not continue to graduate as scientists or technologists. Do women not want to become scientists or do they not want to study the kind of courses the University offers?

This paper will examine the failure of current course provisions attract women students; discuss courses currently being developed which may more accurately suit women's needs; reflect on intervention measures to make the current curriculum more accessible to women; and reflect on the success of additional measures of support offered to women studying science and technology.

CONSTRUCTING WORLD PICTURES

Kis Bonde

Les images du monde, religieuses ou scientifiques, déterminent le cadre de nos pensées. Les plus récentes théories de la philosophie des sciences s'entendent toutes pour dire que ce sont les êtres humains qui ont créé et construit les images du monde. On appelle cela le CONSTRUCTIVISME. Les images du monde varient en fonction de notre compréhension et de nos connaissances personnelles, ainsi que de concepts et d'attentes bien ancrés. Les plus importantes images du monde sont toutes «dessinées» par des hommes et reflètent leur propre bagage d'expériences et de concepts. Il semble être temps aujourd'hui d'assurer la participation des femmes et des jeunes filles dans l'élaboration de ces images et d'y inclure leurs modèles et interprétations mentaux. Il est temps également d'apprendre aux jeunes femmes à devenir des «dessinatrices cartographes» créatives, de façon à ce que les «cartes» du monde reflètent aussi leur propre monde.

Contributions - GASAT 7 International Conference, Canada, 1993
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CONSTRUCTING WORLD PICTURES.

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Abstract.
World pictures, whether religious or scientific, determine the frames of our ways of thinking. Newer theories of philosophy of science agree that all world pictures are created and constructed by human beings. This is called CONSTRUCTIVISM.[1]
World pictures differ according to personal understanding, knowledge, already gained concepts and expectations.
Dominant world pictures are all constructed by males, and they reflect their world of experience and concepts. Now it seems timely to introduce girls/women as constructors and to include their mental models and interpretations.
Today we should teach also girls to become creative " map-drawers ", so the " maps " of the world we know might be transformed by their worldviews.

World Pictures.

The greater part of all human beings have their ideas and thoughts framed by religious myths, others by a certain ideology, and only a smaller part of the population of our world in Nothern America, Europe, Japan, Australia etc. are also influenced by the scientific - technological world picture (paradigm).
Different world pictures lead to different norms and values, which are often incompatible.
The dominant religious - and scientific world pictures do have one thing in common: They are all constructed by men.
The interpreters are also men : Priests, philosophers, physicists etc.
Religious world pictures are rather static, and they are transferred from one generation to the next by telling and reading about myths, rituals, tradition and eternal truth and dogmas as guidelines of life.
The scientific world pictures are in continuous alteration or transformation, and they are transferred to the next generation by our textbook systems. These world pictures build on criticisme and doubts rather than pure belief and dogmas. They do not try to answer questions as, " Is there a meaning behind existence ?"
They try to describe , explain and predict phenomena in and around us and to talk about reality in a consistent and rational way, rather than about eternal truth.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

History and Learning.

The world picture spread by Christianity was mainly the Genesis influenced by the learning of Aristotle.
Learned people have studied these concepts for about 2000 years, even if not one sentence from " Genesis " and only a few by Aristotle are scientifically acceptable today.
However, our younger pupils at school seem to carry on the Aristotelian world picture believing that soil, water and air are the basic elements from which everything is made.
Teachers ought carefully examine the world pictures of their pupils in order to use them as platform for teaching.
Constructivism as a cognition theory indicate that pupils will only learn according to their own world pictures.
Our young pupils will pick out the knowledge they believe will function in their everyday life. If we want to transfer other ways of thinking, abstract thinking, alternative models, simulation etc. - it is a hard job to circumvent the immediate utilitarian attitude of child during the learning process.
It is difficult to convince the children that scientific insight demands a new way of thinking.
The evolution theories of Charles Darwin (1809 -1882) conflicted with the static creationist viewpoint of the church and static Neo-platonic/ Aristotelean thinking.
It was a revolting thought that everything evolved and changed instead of being as God's creations, and it was an offence to regard human beings as animals especially for moral reasons.
The constructivist cognition ideas have some trends in common with the theories of evolution : Knowledge will adapt to the surroundings, and an individual selects the knowledge and theories, which are successful to act upon or for survival in her world.[2] A biologist might well die in the deserts of Australia, while an aboriginal has the knowledge about nature, which is urgent to survive.
The biologist may be good at classifying plants and animals, but the aboriginal will be good at tracking them.
When a well functioning world picture is spoiled by the white man enforcing Christianity and science, disaster follows.It happened to the aboriginals, and most known to the Danes are the troubles of the Greenlandic Inuits trying to adapt to our way of living.

Power.

Dominant world pictures are built on power. The Christian church built up a hierarchical system with male dominans, very much opposed to the characters of Jesus himself.
The myths telling about the Father, the Son and the Holy

Spirit are clearly constructed by men, as the Mother, the Daughter and the Body are NON-existent.
Today the church's affiliation to power has faded, resulting in a majority of female theology students in Denmark. Caring for our souls tends to become a female job.
The scientific world picture of the white man has gained tremendous power because of its superior ability to describe, explain, predict and control phenomena and events in nature, and because of its aggressive technology.
Consequently our part of the world has achieved an unprecedented degree of exploitation of nature for better or worse.
We have eaten from " the tree of knowledge of good and evil" and we have used our knowledge to welfare and warfare: technical devices to facilitate our lives as well as endangering our existence.

The World of Women.

How did it happen that the women's world of experience and concepts were excluded from the fields of science?
Many factors could be mentioned:
First of all women were burdened with demands from the NEAR surroundings and were forced to use all their strenghts and time on that. They had no time to concentrate upon distant, abstract problems, much less transcend the doings of everyday life and the childbed neither in ancient Greece nor at the time of Newton.
Technical facilities in our homes and birthcontrol are reasons why our young women are no more entirely bound to their homes.
Secondly the women could not qualify through the educational system, and their entrance at the Copenhagen University was delayed 400 years compared with men.
1992 is the first year ever, where more women than men study at the Danish universities , --- but not in physics.
For a long time women never had their knowledge systematized . Their knowledge was concrete experiences and sympathetic insight with life and nature. Care for the continuation of life, bringing up, making things grow, protection and conservation were and still are the main themes of women's lives.
No wonder that insecurity occurs amongst our girls and young women, when they realize that their knowledge and values seem to be of minor importance to traditional science.
Teachers should help the girls consider, if a new science could be constructed: A science and technology of care for

life and nature.
Knowledge from their world of experience, sympathetic insight and empathy might be combined with the traditional aims of physics, where every theory and model has to be submitted to experiments and to new observations.
Refutation as a possibility is still a challenge.
The constructivist idea of cognition questions the fixed borders between subjective and objective knowledge. No observation is regarded as purely objective, but on the contrary observations are influenced strongly by the theoretical perspective of the observer.
Consequently there is no simple connection between the mental world and the " real " world. The methodology of physics is a mixture of curiosity and doubt, and presumably more than one theory might describe a phenomenon in a consistent way.
This is a strong argument to consider GENDER and SCIENCE and TECHNOLOGY.

New World Pictures.

A persons world of experience and social norms influences even scientific interpretations.
Presently it is not considered relevant to find the truth, rather we accept theories or models.
A paradigm of complexity, where self-regulation, multiplicity,quality, subjective experiences, time and wholeness are included, has emerged.
Cyclicity is reaccepted rather than linear progress,which has dominated our models.
The Danish physicist Niels Bohr said," Physics concerns what we can SAY about nature; it is not necessarily Reality itself ".
SO LET THE GIRLS SPEAK !!!
Surely they will transform some of the male constructions, which mainly focus on ability to predict, control and too often leads to exploitation of nature.
Teachers must be concerned helping the girls making syntheses, constructing analogies, differentiating structures, generalizing etc. Activities and constructions, which the girl herself must carry out using her imagination and already achieved experiences.
A teacher does not teach a new concept, but helps the pupil construct her own understanding. By self-regulation new structures of thought develop successively.
I foresee our girls/women as interpreters of their equally important " realities ".
Alternative " maps " and patterns will be created and new questions demand new answers.
The new " maps " will pay attention to important aspects of

women's lives, and they will expose male biased interpretations and omissions.
" Woman the Gatherer " has already been brought into focus on the same footing as " Man the Hunter ", and Cooperation is as important as Competition in terms of natural selection.[3] May be we need more than one " map " to describe all aspects of our reality, and anyway no " map " is identical with the landscape itself.
Physics is the subject, which least of all attracts girls in Denmark (together with datalogy).
Modern physics is mainly concerned with the structures beyond the senseable world (atoms, wawes), where only indirect measurements are submitted to interpretation.
If physicists would broaden their fields of study,there might also be a field for naturecare (biophysics, geophysics), where the relationship is based on ethics, ecology, empathy and cooperation with nature instead of technology and economy, where man is opposed to nature by exploiting it.
The aim of science might instead be seeking a healthy and sustainable world rather than pretending seeking the truth.
The intention of teaching science might be to urge our pupils to become constructors of theories, models and "maps" and to act in the light of their knowledge for the benefit of society and nature.
Thus teachers must be aware of the constructivist cognition theories, which build upon self-regulation, curiosity and the existence of structures of thought.[2] They must carry out a gender inclusive teaching knowing that the perceptions of our physical surroundings are a product of already aquired knowledge, experiences, expectations and concepts.
In a way there are as many world pictures as human brains, every person has his/her personal " UMWELT ".
However, in every culture we share some common knowledge, and some world pictures become more dominant and powerful than others. They determine the frames of our lives, and may be it is time that women themselves took part in constructing the framework.

Notes:
1) Constructivism is an epistemology influenced by many persons: Jean Piaget , Schweitzerland.
Jerome Bruner, U.S.A.
Lev Vygotsky, Sovjet.
Karl Popper, Thomas Kuhn and Poul Feyerabend (philosophy of science).

2) Self-regulation.
Discrepancy between expectation and observation disturbes the equilibrium, which the person will now seek to regulate by thinking and acting.

Curiosity.
Being curious and inquisitive we build up a knowledge that might be valuable for later adaptions and survival.

Structures of thought.
Structures of thought refer to different cognitive organisations held by a person's brain.

3) Linton, Sally . " Woman the Gatherer " , Male bias in anthropology . Jacobs, S.E. (ed) " Women in Perspective ---", Urbana, I.L.
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LES FEMMES DOIVENT FAIRE LEUR PLACE DANS LE GÉNIE

Marielle Dufresne

Engineering remains a field in which the proportion of women is low. Studies conducted by the Quebec Order of Engineers point out a number of hurdles to a more sensible increase in the number of women engineers. These also show that the profession must strive towards integration so that women interested in a career in engineering may persist in their option.

In order to determine means of increasing the number of women engineers and ensure a viable career in engineering, the Order has created a task force with the mandate to lead the development of a two-year plan of action. Strategies suggested are based on promoting the profession to female teenagers and adding greater emphasis on the role women play in engineering.

LES FEMMES DOIVENT FAIRE LEUR PLACE DANS LE GÉNIE

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RÉSUMÉ

Le génie demeure un domaine où la proportion des femmes est faible. Les études menées par l'Ordre des ingénieurs du Québec mettent en évidence un certain nombre d'obstacles à un accroissement plus sensible du nombre d'ingénieures. Elles montrent aussi que la profession doit déployer des efforts d'intégration de manière à ce que les femmes intéressées par une carrière en ingénierie persistent dans leur choix.

Dans le but de déterminer les moyens d'accroître le nombre de femmes en ingénierie et de s'assurer qu'elles y feront carrière, l'Ordre a créé un groupe de travail dont les travaux ont mené à l'élaboration d'un plan d'action échelonné sur deux ans. Les stratégies proposées reposent sur la promotion de la profession auprès des adolescentes et la diffusion plus large du rôle des femmes en ingénierie.

INTRODUCTION

Au Québec, alors qu'elles sont plus nombreuses que les hommes dans 7 des 10 grands secteurs de l'éducation de niveau universitaire, les femmes occupent une place bien discrète dans les facultés de génie et ne suivent que de loin le mouvement de fond amorcé dans les cégeps et les universités.

De plus, une fois qu'elles ont terminé avec succès leurs études et obtenu un emploi d'ingénieur, plusieurs jeunes professionnelles se découragent devant les barrières érigées par ce milieu de travail encore réfractaire à leur venue.

UNE EXCEPTION DANS L'ASSAUT FÉMININ DES CÉGEPS ET DES UNIVERSITÉS

Selon les plus récents travaux de recherche effectués par le Conseil supérieur de l'éducation du Québec sur les fluctuations des milieux post-secondaires, la décennie 90 serait marquée par une augmentation du nombre de filles qui s'accompagnerait d'ailleurs d'une baisse du nombre de garçons. Les filles représentent maintenant 60% de l'effectif étudiant et réussissent mieux que les garçons, qui ont de plus en plus tendance à abandonner leurs études. C'est donc dire que la prépondérance des femmes diplômées caractérise la nouvelle réalité collégiale et universitaire des années 90.

De plus, les filles obtiennent de meilleurs résultats que les garçons, et elles sont plus jeunes qu'eux quand elles arrivent à la fin de cette étape académique. Ainsi, à 17 ans, une fille sur deux accède à un programme menant à un diplôme d'études collégiales, contre un garçon sur trois seulement.

Résultat, le succès féminin au cégep se répercute directement sur le taux d'accès des femmes à l'université, où elles se retrouvent massivement dans des programmes contingentés. Aujourd'hui, 57% des femmes fréquentent l'université et sont majoritaires dans les facultés de sciences appliquées et dans six autres des dix grands secteurs de l'éducation, soit la santé, les lettres et l'éducation, les arts, les sciences humaines, le droit et l'administration.

Il semble que cette transformation marquée de la clientèle étudiante ne soit pas un phénomène passager. Le Conseil supérieur de l'éducation est en effet convaincu que l'on assiste plutôt à l'émergence d'une tendance profonde dans la société québécoise.

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DES PRÉJUGÉS CORIACES ET DES OBSTACLES RÉELS

Cependant, malgré un net redressement au cours des dernières années, force est d'admettre que le génie échappe encore à cette vague de fond. Même si le Québec est à l'avant-garde en affichant des taux d'inscription féminine supérieurs à la moyenne canadienne en première année de génie, la carrière d'ingénieur est encore boudée par les jeunes filles. Et malheureusement, une fois qu'elles ont décidé d'y plonger, trop peu de femmes persistent dans cette profession qui est encore perçue comme un bastion masculin. Ainsi, au mois de décembre 1992, seulement 2 175 femmes étaient inscrites au tableau de l'Ordre sur un total de 36 974 membres, ce qui représente un faible pourcentage de 5,9%. C'est bien peu, surtout quand on le compare à celui d'autres corporations. La Corporation professionnelle des comptables agréés compte 20% de femmes, l'Ordre des médecins 25% et l'Ordre des chimistes 28%.

On a identifié de nombreux obstacles à la présence des femmes en génie. Ils sont surtout liés au stéréotype des rôles joués par les hommes et les femmes dans notre société ainsi qu'à l'image projetée par la profession d'ingénieur elle-même. Ces fortes perceptions jumelées à une culture scientifique quasi inexistante au pays et à des conditions de travail très exigeantes n'encouragent pas les femmes à emprunter cette voie non traditionnelle. En outre, les modèles féminins y sont extrêmement rares, et ceci, dès les études post-secondaires, notamment à l'université où la quasi-totalité du corps enseignant est masculin. Par exemple, l'École Polytechnique de Montréal ne compte que 11 professeurs féminins sur un total de 215.

L'Ordre des ingénieurs du Québec qui n'est pas insensible à ce déséquilibre, veut promouvoir l'équité et l'égalité des chances pour tous ses membres. Il a donc décidé de s'attaquer de front à cette question, en sensibilisant les milieux concernés et en soutenant par des moyens concrets les femmes qui veulent faire carrière en génie.

LE PROFIL DES FEMMES EN INGÉNIERIE

En mai 1990, l'Ordre des ingénieurs du Québec déposait à la Conférence nationale du Comité canadien des femmes en ingénierie, un mémoire intitulé « Profil, stratégies et attentes des ingénieures ». Ce document fait état des résultats d'une enquête menée auprès des 1 410 femmes inscrites au tableau de l'Ordre au 31 mai 1990.

D'après l'analyse des 610 questionnaires traités, on peut dégager le profil de ces professionnelles. D'abord, elles sont beaucoup plus jeunes que leurs confrères masculins, moins expérimentées, et donc moins présentes au sommet de la hiérarchie de l'entreprise. Elles ont pourtant une scolarité supérieure à la leur puisque 32,5% des femmes détiennent une maîtrise ou un doctorat, contre 22,3% des hommes. Elles sont en grand nombre en génies mécanique, électrique et civil, et elles sont même surreprésentées en génie chimique et en génie industriel. Elles apparaissent également un peu plus nombreuses que les hommes dans la fonction publique et elles se retrouvent surtout en région, comme en Abitibi, en Estrie ou encore dans l'Outaouais. En revanche, rares sont celles qui occupent des postes en dehors du Québec.

De façon générale, on peut dire que les femmes jouissent des mêmes conditions de travail que leurs confrères aux

chapitres du travail à temps plein, des honoraires, des vacances et du faible niveau de syndicalisation. Cependant, on note un écart salarial de 3% qui serait dû à la moins grande expérience de travail chez les femmes. Il semble par contre qu'elles occupent une place équivalente à celle des hommes dans le secteur du génie-conseil et de la fabrication. En outre, comme eux, elles ont eu peu de difficultés à se décrocher leur premier emploi.

DES BARRIÈRES SUR LA VOIE DE L'ÉGALITÉ

Dans le cadre de cette enquête, les femmes interviewées ont relevé les principaux obstacles qui les empêchent encore d'évoluer en toute équité dans cette profession à prédominance masculine. D'après leurs expériences, les dirigeants d'entreprise seraient les premiers à ne pas les traiter sur le même pied que les hommes. Ils montreraient même certaines réticences quant à leur intégration totale dans les équipes de travail. La direction de l'entreprise ne leur donne pas accès d'emblée à la formation continue et elle ne leur demande que trop rarement de participer à des projets majeurs.

Sur le plan de leurs relations avec leurs collègues de travail, il ressort clairement que les femmes parviennent difficilement à s'affirmer et à exercer l'autorité requise sur les techniciens masculins. De plus, elles souffrent encore de discrimination quand il s'agit de postuler des emplois de niveau supérieur. Enfin, le manque de flexibilité des horaires de travail leur permet difficilement de concilier responsabilités familiales et vie professionnelle.

Pourtant, elles s'accordent à dire qu'elles sont prêtes à

fournir tous les efforts nécessaires pour se faire reconnaître. Ainsi, elles acceptent de travailler plus fort que leurs collègues masculins pour faire leurs preuves et se tailler une place de choix elles aussi.

Elles sont déterminées à s'intégrer dans les équipes de travail. La plupart d'entre elles ont donc mis de côté leur agressivité et utilisent plutôt l'humour pour contrer les blagues sexistes de mauvais goût.

Ce qui est frappant, c'est que malgré toutes les embûches, une forte majorité de nos ingénieures québécoises ont affirmé qu'elles n'hésiteraient pas à refaire le même parcours, car elles reconnaissent unanimement que le défi professionnel vaut le coup.

Cependant, toutes sont conscientes du niveau de détermination et de persévérance nécessaire pour arriver au bout du tunnel. Elles insistent donc sur l'importance de mieux informer les femmes sur la carrière d'ingénieur et sur la nécessité de s'attaquer de front aux préjugés négatifs solidement ancrés dans ce milieu professionnel. D'ailleurs, les ingénieures interviewées ont fait de nombreuses suggestions très positives qui ont servi à orienter les actions de l'Ordre.

LE GROUPE DE TRAVAIL ET LE PLAN D'ACTION

Deuxième étape afin de donner suite aux besoins exprimés par ses membres féminins dans le cadre de cette enquête, l'Ordre des ingénieurs du Québec a créé un groupe de travail chargé de faire des recommandations pertinentes pour faciliter l'accès à la profession et faire tomber ces barrières nuisibles.

À l'issue de rencontres fructueuses, le groupe de travail a proposé un plan d'action échelonné sur deux ans. La troisième étape entreprise par l'Ordre depuis janvier 1993 consiste donc en l'application de ce plan d'action. Il se divise en quatre volets : l'éducation, les modèles, le support et les communications.

En résumé, on peut dire que certaines actions visent à modifier les fausses perceptions et à mieux faire connaître la profession aux jeunes, aux enseignants, aux conseillers d'orientation et enfin à l'ensemble du public. Le plan d'action prévoit, notamment, de publier des fascicules destinés aux conseillers d'orientation dans le but de les informer sur la profession; d'organiser une campagne publicitaire autant auprès des jeunes que du public afin de démystifier le génie; de faire connaître régulièrement les réalisations de femmes en ingénierie.

D'autres actions ont surtout pour but d'épauler les femmes ingénieures et de les inciter à être plus actives dans leur réseau professionnel. En outre, certaines actions ont pour objectifs de valoriser ces professionnelles et de dégager des modèles féminins auxquels les jeunes filles pourront s'identifier. Pour atteindre ces objectifs, le plan d'action préconise de mettre sur pied un comité provincial pour la promotion des femmes en ingénierie, ce qui est effectif depuis février dernier. L'Ordre veillera également à encourager les candidatures féminines au sein de ses comités et du Bureau, dans la mesure du possible. Pour favoriser les regroupements entre femmes ingénieures, l'Ordre organisera au cours de la prochaine année des activités telles que des « 5 à 7 », des conférences et des déjeuners-causeries. Ce plan d'action, amorcé depuis janvier 1993, devrait avoir des retombées

positives au cours des prochaines années.

CONCLUSION: PERSISTER ET TRACER LA VOIE...

Les efforts que nos pionnières ont consentis à la profession d'ingénieur dans un contexte moins favorable n'ont pas été vains. Leur apport positif commence à être reconnu et les modèles féminins surgissent de plus en plus.

À preuve, cette entrevue que les directeurs d'école ou de faculté de génie ont accordée à la revue Forces à l'été 1991. La plupart ont fait valoir que l'arrivée des femmes dans leurs institutions a fait gagner du terrain aux préoccupations concernant les impacts sociaux et environnementaux des technologies. Le président de l'École Polytechnique de Montréal de l'époque, M. Roland Doré, affirme en effet que « les femmes ont contribué à changer la mentalité des jeunes ingénieurs aussi bien que celle des enseignants, car en abordant un problème d'ingénierie, elles considèrent également d'autres aspects que la seule dimension technologique ».

M. Gaston Denis, le vice-doyen à l'enseignement de la Faculté des sciences appliquées de l'Université de Sherbrooke souligne pour sa part que « les filles ont davantage que les garçons de préoccupations pour le vivant et les aspects sociaux, humains et globaux des choses ». Elles sont également plus sensibilisées aux questions d'environnement et de santé au travail. Ce n'est donc pas surprenant, selon lui, qu'on les retrouve dans des domaines comme le génie chimique et le génie civil.

Les ressources et les compétences féminines deviendront indispensables au cours des prochaines années. En effet, avec

le vieillissement de la population, il sera difficile, en génie comme dans d'autres professions, de renouveler et de maintenir un bassin adéquat d'ingénieurs. Il est donc nécessaire, si la profession d'ingénieur ne veut pas être distancée par la très grande majorité sinon la totalité des autres professions, que l'entrée des femmes, amorcée depuis à peine quelques années, non seulement se poursuive, mais s'accentue rapidement.

Il faut donc le plus vite possible mettre en valeur les modèles féminins, intéresser les femmes au génie et surtout épauler toutes celles qui ont décidé de faire leur place dans cette profession en pleine ébullition. Dans le génie comme dans les autres secteurs professionnels, les femmes peuvent apporter une contribution qui fera toute la différence dans l'intégration harmonieuse des valeurs scientifiques, économiques et sociales.

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WOMEN IN ENGINEERING IN CANADA: A NATIONAL PERSPECTIVE

Monique Frize, P.Eng.

Une chaire nationale pour le programme des femmes en génie a été créée en mai 1989 à l'Université du Nouveau-Brunswick. Son mandat : accroître la participation des femmes en génie au Canada. En février 1990, quelques mois après la tragédie de l'École polytechnique de Montréal, un comité national a été formé pour étudier les obstacles et les possibilités des élèves-ingénieures et des ingénieures. Le comité était présidé par le détenteur de la chaire de l'UNB, ce qui a permis de regrouper, pendant deux ans, un grand nombre des activités des deux groupes. Le Comité canadien des femmes en génie a publié son rapport en avril 1992; le rapport contenait 29 recommandations, dont des délais et des stratégies, et a été appuyé, peu après sa parution, par des centres de responsabilité clés au sein de la profession. Le Comité canadien des femmes en génie n'existe plus, mais la chaire du programme des femmes en génie de l'UNB continue d'encourager les organismes à mettre en oeuvre des recommandations et à partager des stratégies et critères de mesure du succès avec les parties intéressées du pays tout entier.

WOMEN IN ENGINEERING IN CANADA: A NATIONAL PERSPECTIVE

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ABSTRACT

A national Chair in Women in Engineering was created in May 1989 at the University of New Brunswick. It's mandate: increase the participation of women in engineering in Canada. In February of 1990, a few months after the tragic event at Ecole Polytechnique, a national Committee was formed to study barriers and bridges for women engineering students and engineers. The committee was chaired by the Chair holder at UNB, thus merging for two years many of the endeavours of both groups. The Canadian Committee on Women in Engineering (CCWE) released its report in April 1992; the report contained 29 recommendations, with timeframes and strategies and has been endorsed, shortly after its release, by key responsibility centres in the profession. The CCWE no longer exists, but the Chair in Women in Engineering at UNB continues to encourage organisations to implement recommendations and share strategies and measurement of success criteria with interested parties across the country.

INTRODUCTION

The national average enrolment of women in Canadian engineering schools was 12 percent in 1988, 16 percent in 1990 and estimated to be 18 percent in 1992. The 1990 enrolment was somewhat higher for women in mathematics and physical sciences (29 percent) and similar to engineering for women enrolled in engineering technology programs in colleges (16 percent). In the labour market, women make-up 58.2 percent of the total workforce, but only 3.3 percent of the certified technicians and technologists across the country, 7.5 percent of engineers and 18.9 percent of specialists in the physical sciences. In 1991, there were 15 percent women in Engineering Master's programs, 11 percent in doctoral studies and 3.6 percent Faculty. (SOURCE: Statistics Canada; Education, Culture and Tourism and CCTT; CCPE). The under-representation of women was a main factor in the creation of the Canadian Committee on Women in Engineering (CCWE) which carried out a two year study

of the level of participation of women in engineering study programs and workplaces. The gender-balanced committee of nineteen members, representing industry, the government, the profession, universities, deans, students and elementary and secondary educators, was given the mandate to uncover the social, environmental and cultural barriers responsible for the low enrolment of women in engineering, and to develop strategies and programs to integrate them as full participants in the profession.

THE CCWE'S PROCESS

The CCWE's deliberations which lead to the preparation of the report was widely consultative and iterative. The process consisted in collecting information from women and men engineers, educators and parents, during six public forums held across the country. Written submissions and letters were added to the information collected at the forums. In addition, research was done on "effective practises" in seven universities and six workplaces. All the information collected during the first 14 months became the primary source for the preliminary report which prepared a draft of recommendations and presented them at a national conference. The participants (over 250, one-third of them men) discussed the recommendations, assessing priority, content, relevance and whether they were realistic and implementable. This step helped to prepare 'final' recommendations which were presented and discussed at an "endorsement" meeting in September 1991 with invited delegates (fifty) from the major responsibility centres across Canada. Only minor changes in the document occurred after that last consultation and the final report was released on April 7, 1992, containing twenty-nine recommendations, with strategies, timeframes and citing the responsibility centres expected to implement them. The report, "More Than Just Numbers", was divided into four major categories: the childhood years, university education, the workplace, and the profession itself.

KEY ISSUES

The CCWE studied the barriers which prevent young women from choosing engineering as career and concluded that the "cultural influences and biases that channel girls away from

non-traditional careers in the pre-school years start with parents and other care-givers. Once in school, many girls and young women continue to be discouraged from pursuing interests and careers in mathematics, science, technology and engineering by those teachers and guidance counsellors who are not sensitive to gender stereotyping. These issues have created systemic barriers which prevent young women from choosing these careers" (CCWE Report, 1992).

In universities, the predominantly male culture may make some women feel excluded, isolated. In the workplace, women often encounter attitudes and activities that are systemically biased, especially regarding hiring and promotion practises. In order to continue to attract more women in non-traditional occupations, employers must be sensitised to matters of equity and gender-stereotyping. If Canada is to succeed in increasing the participation of women in the fields of science, technology and engineering, all aspects of attraction, retention, hiring and career development must be addressed concurrently.

SOLUTIONS

The CCWE report provided a general guideline for organisations to measure where they stand on the issues and on the solutions. The Committee stated clearly that many organisations may have already implemented some of the programs before the report went to print. However, the committee felt that it was important to present the entire picture for those organisations that are just beginning to be sensitized on these questions. Another interesting point is that the process itself, the consultations, the collection of research, the public forums, the conference and the endorsement meetings have probably done much to sensitise the main parties concerned as to what needs to be done.

ASSESSING PROGRESS AND IMPACT OF THE REPORT

In the first twelve months following the release of the report, over 1300 copies were purchased in Canada and dozens from organisations in the USA and overseas. Key responsibility centres have formally endorsed the report. Amongst these is the NCDEAS (National Committee of Deans of Engineering and Applied Science); this group is currently

assessing which of the recommendations of the report have been implemented in each university, which ones have not. This baseline will establish what is left to be done and the deans will then develop an action plan to implement many of the remaining suggestions.

CCPE (Canadian Council of Professional Engineers), an umbrella organisation linking the twelve provincial and territorial professional engineering associations in Canada is another group who endorsed the report. The CCPE has created a joint Ad Hoc committee with the Deans and the UNB's Women in Engineering Chair, to develop an action plan to implement the recommendations of three reports, including the CCWE report. The CCPE committee is also collecting a national inventory of projects whose objectives are related to the CCWE's objectives. This will enable everyone to share ideas, minimize duplication of efforts and create new partnerships. Progress can already be measured by the increase in the enrolment of women in engineering schools across the country. An improvement in student publications has been noted, although some sexist ones still occur from time to time. These acts of blatant sexism or of vulgarity cannot remain hidden as they hurt the image of the profession and they must stop.

PROMOTING THE REPORT AND SHARING PROGRAMS ACROSS CANADA

The creation of the Northern Telecom/NSERC Women in Engineering Chair at the University of New Brunswick had two main objectives: the Chair holder was to be a role model by teaching and doing research in engineering, and develop programs and strategies to increase the participation of women in this profession. The Chair has a national mandate, whereby programs and strategies are shared with interested parties across the country. More recently, when the CCWE was disbanded following the release of the report, it was felt appropriate for the Chair to continue to publicize the existence of the CCWE report and to encourage organisations to implement its recommendations.

The Chair holder and two assistants, Jane McGinn-Giberson, P.Eng. and Gisèle Levesque, P.Eng. have developed several programs, amongst which are:

1. In the elementary and secondary education sector

***** Approximately 150 school presentations have been made to approximately 10,000 students, one third in elementary schools and the remainder in junior and senior high schools in New Brunswick, of which 60 percent were girls. A script was developed for these presentations and this project led to the creation of a video, "Engineering: Design Tomorrow's World", released in September 1992. The video informs young people of the importance of studying mathematics and science in high school, to keep their options open, and de-stereotypes engineering by showing role models (women engineers, to counterbalance the overwhelming presence of men in the profession) solving problems, working with people, and creating the world we live in. A French version will be released in the Spring. The video was tested with 75 girls and boys in grade 9; the result was a positive effect on both genders.

Measure of Success: In the past three years, the proportion of women enrolled in engineering at the university of New Brunswick and at Université de Moncton has doubled. The goal in the next few years is to continue to see an increase of 2 percent per year.

***** An engineering and science summer camp will be set-up in the summer of 1993. The program will be similar to the Science Quest camp at Queen's University. The camp is intended for students from grades 5 to 8 with a 50 percent participation of girls; its unique aspect is that it will provide activities in both official languages, and the camp will move to various areas of the province of New Brunswick to make it accessible to many of its smaller communities.

Measure of Success: The program will track how many of the campers choose science, technology or engineering for their post-secondary study program. The goal is to see at least half of that population choose these subjects as a study program in post-secondary institutions.

***** Meetings with parents of students in elementary or secondary schools will be organised in each of the eighteen School Boards of the province. The goal is to sensitise

them on the importance of providing gender-neutral career counselling, discussing the importance of building self-esteem in girls and increasing their awareness of how gender stereotyping can hamper their potential development. This program will be implemented over a five year period starting in 1993, and will be accompanied by presentations to the students during the day.

Measure of Success: The enrolment statistics of the women students entering Engineering at UNB will be tracked over the same period, for each of the areas visited. The goal is to see the proportion of young women admitted into engineering be 25 percent of all those admitted from each of the high schools visited, within a two year period.

***** A tour of role models to talk to children from aboriginal communities about non-traditional careers will be organised. The purpose is to provide a message to these young people that an education can provide them with a bright future and a career that they can enjoy and be successful at.

Measure of Success: The enrolment of aboriginal students in engineering at the University of New Brunswick will be tracked between 1994 and 1997. An increase of 2 percent per year is the goal.

Other programs include workshops and sessions with teachers and guidance counsellors on the appropriateness of engineering career choices for girls and young women and organising sessions and visits at the Engineering Faculty at UNB for groups of young women, upon request.

2. University Sector

***** A Network Project: In 1993, a national network and newsletter for recruitment and retention officers of women in engineering programs across the country (33 universities) is being implemented; the newsletter will appear three times per year, initially. The main goal is to provide a forum for the exchange of information on successes and failures on recruitment and retention strategies and keep up to date with current literature on the topic.

Measure of success: The goal is to receive information for the newsletter from at least 25 percent of the network contacts persons within a year and to double the membership within 12 months.

***** Over 20 speeches and lectures have been given by the Chair holder to engineering students across the country on how engineering ethical principles should be extended to gender equity, sexual and personal harassment, and a respectful attitude and behaviour towards all peers, colleagues, employees and managers. At the University of New Brunswick, the Chair gives a lecture on this topic in each of the Engineering Profession courses given, thus reaching most students before their graduation. In other universities, this is done through speeches and invited lectures and speaking at conferences such as the Canadian Congress of Engineering Students.

Several discussions were held at various universities with deans and professors, not only on the 'expanded view of ethics' but also how the environment,language, teaching style, and stereotypical attitudes may influence the success and failure and the attraction and retention of women students. Speeches have been given on these topics at the Canadian Conference on Engineering Education (Frize, 1990, Frize, 1992).

Measure of Success: Changes in the environment of engineering schools can be measured in three ways: (i) the level of enrolment of women; (ii) their retention; (iii) results of surveys on the level of comfort of the environment, use of gender-inclusive language by professors, attitude of the men students and professors, and the proportion of women faculty hired.

3. Employers and engineers

***** Workshops to sensitise employers and engineers on how to improve the environment and quality of experience of women engineers in industry and the benefit of hiring and retaining women in technical occupations have been organised and delivered. The purpose of this project is to bring the message to workplaces that hiring women in technical and

scientific occupations will enrich and diversify perspectives and enrich the solutions. The Chair holder conducts workshops for large, medium and small companies whenever they can be scheduled, upon request.

Measure of Success: The women and men graduates in engineering at UNB will be tracked between 1993 and 1997 to verify the hiring patterns. Success will be defined as an equal proportion of women hired to that of the men, according to the ratio of graduates in any particular year. A survey of women engineers will track the level of progress made by the workplaces.

CONCLUSION

Women will bring many qualities to the engineering profession, such as communication and interpersonal skills and a consensus building approach that facilitates team work. Executives of major companies often state how important these qualities are.

The presence of women in engineering will bring the field closer to societal needs. Recent research (Coates, 1990) also shows that women have strengths in the area of characterising and conceptualising problems which relates to innovation, while men's strengths is in actually solving the problem. It is through innovation and good marketing techniques that Canada will be successful in the global marketplace. A gender-balanced perspective will ensure that all talents are used in a field that has only used half of its potential for so long. After all, products and technologies must be appealing to both genders.

It is hoped that this project will make equity, fairness and a comfortable environment a reality in schools, universities, workplaces, and associations in the nineteen nineties. Much has been done. But much is left to be done, especially in the workplace. This is where we must now turn our energies, because if it does not improve, the unhappy stories of disillusioned women will create backlash, and women may, once again, stay away from unfriendly occupations. Effecting changes of attitudes and behaviour takes time and it cannot be done overnight but it is urgent that every Canadian becomes a part of this change.

Our task, in the Women in Engineering Chair, has been and continues to be: working towards gender equity in the engineering profession: not in reaching equal numbers of women and men but in reaching equal chances of success and career development, in the respect obtained from peers and employers; it means a world where harassment (personal or sexual) has disappeared; it means a culture where diversity is valued. Occupations in non-traditional fields pay well. If more women feel comfortable in making these choices, they will achieve economic independence which, in turn, will give them more control over their lives.

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INCLUDING MEN IN GENDER-INCLUSIVE DEVELOPMENTS AND PRACTICES: POTENTIALS AND DILEMMAS

Colin Hocking

Quelles sont les meilleures façons d'impliquer les hommes dans le processus d'élaboration de pratiques sans distinction des sexes dans les sciences et l'enseignement des sciences? Les problèmes entourant la question réapparaissent sans cesse. Par exemple, les hommes constituent la majorité du corps scientifique et du corps professoral scientifique. Par conséquent, toute transformation des sciences et de l'enseignement des sciences impliquent automatiquement la participation des hommes. D'autre part, les hommes ont été largement responsables de l'iniquité et du caractère destructif des pratiques dans les sciences et l'enseignement des sciences. En conséquence, les hommes devraient prendre la responsabilité d'en élaborer de nouvelles plutôt que de laisser cette tâche aux femmes.

Centrales à la question d'impliquer les hommes dans de tels efforts sont les relations de pouvoir actuelles au détriment des femmes au sein de la société. Les inégalités sexuelles dans les sciences et l'enseignement des sciences contribuent à perpétuer ces relations de pouvoir inégal. Ainsi, bien que les hommes devraient participer à la transformation des sciences et de l'enseignement des sciences et en prendre la responsabilité, on ne peut se permettre de laisser le soin aux hommes uniquement d'entreprendre cette tâche importante sans tenir compte des femmes et de leurs expériences. Pas plus qu'on ne devrait d'ailleurs laisser les femmes décider seules des changements à apporter : par principe, parce que ces décisions affecteront aussi les hommes; et en pratique, parce que les hommes sont actuellement en majorité dans le domaine.

Dans le cadre d'autres questions de relations entre les sexes au sein de la société, les hommes ont été impliqués à une transformation similaire à celle dont on parle ci-dessus. De telles questions incluent l'égalité des chances et les programmes d'action positive, ainsi que des programmes qui traitent des agressions sexuelles et du harcèlement sexuel. Ce document traite de ce qui a été accompli dans le cadre de ces différents programmes et des conséquences et suggestions qui en découlent pour la participation positive des hommes au processus de développement des sciences et de l'enseignement des sciences sans distinction des sexes.

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INCLUDING MEN IN GENDER-INCLUSIVE DEVELOPMENTS AND PRACTICES: POTENTIALS AND DILEMMAS

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ABSTRACT

What are the best ways of involving men in the development of gender-inclusive practices in science and science education? Men constitute the majority of scientists and science teachers, so any transformation of science and science education necessarily involves participation by men. In addition, men have been largely responsible for the development of the current inequitable and destructive practices in science and science education, so men have a responsibility for their reformation. Central to the issues of involving men in gender inclusive change are the current power relationships that put men at an advantage over women in society. In some other areas of gender relations in society, men have been involved in working for change, in ways that come to terms with these issues. Such areas include equal opportunity and affirmative action programs, and programs that address sexual assault and sexual harassment. I propose that men need to be involved in the development of gender-inclusive curriculum and teaching practice. But I also propose that the involvement of men should be deliberate and negotiated, and not be left to a laissez-faire hope that all will work out somehow for the better.

" Many men of conscience, if they notice they are doing nothing, will want to spend hours and hours justifying their inertia ... They don't want to do anything rash; ... they have not yet received precise instructions from the central feminist committee. All women have to do is ask, they may say. All women have to do is hold their hand, is what they mean."

John Stoltenberg[1]

CONTRADICTIONS IN CHANGE: A PERSONAL VIEW

The science department in which I work is part of a recently formed university, which has its roots in the amalgamation of two post-secondary teaching colleges. At the same time as attempting to maintain an emphasis on effective teaching, my department is endeavouring to build a research profile based on attracting postgraduate students and developing large-scale, fully funded research projects. Included in the five year strategy plan of the department[2] is the specific aim to "develop gender-inclusive curriculum". This aim has several positive aspects. It means that gender-inclusive teaching practice is legitimated as a focus in the

department and all members of staff are notionally committed to it. It allows investigation of gender inclusive approaches to be included as a bone-fide field of activity in both teaching development and research. On the negative side, all full-time academic members of the department are male. All of the appointments to the department were made under a policy of affirmative action for women, and many of the appointments have been in the biological sciences, in which female numbers to degree level in Australia are high. The opportunities for investigating, developing and implementing gender-inclusive teaching practices in the department are affected by both philosophical and practical questions, either about the validity of males undertaking these activities in the absence of input from females, or by questions that consider how best to include females from other departments or universities in these activities.

The questions that arise, in attempting to achieve gender inclusive practices in a typical science department such as ours, are complex. They include the following:

- To what extent, and in what ways, is it possible for men to recognize that science and science education are male constructions that gives males advantages over females?
- Are any of the interests of men served by 'giving over' of power and position to women? Or, if a change is supported by men, is this essentially an ethical, political or practical decision?
- In what ways should, or can, men be involved in the transformation of power relationships, so that women and men gain equivalence?
- In what ways can men contribute to the development of gender-inclusive practices in teaching and research; how should women be involved in such developments with men?

My approach to these questions in this paper is from a pro-feminist standpoint. That is, I accept that if one is identified as female (in my society), this brings disadvantages that those identified as heterosexual male do not have to endure. My intention is not to challenge the foundations of feminism, but to ask what the implications are for women and men attempting to negotiate a future of equality, using feminist perspectives as a basis. The theory and practice of science research and education also leads to profound questions for the relationship between gay and straight men and women, but for the sake of simplicity I have not addressed these issues directly in this paper.

A CONTEXT FOR CHANGING MEN

The past decade has seen the successful formation of groups and organizations that have, as a central purpose, the promotion and development of gender-inclusive approaches to scientific work and study; for example: the McClintock Collective in Victoria[3]; GASAT internationally. Many of these groups have as a principle of action (either overtly or by assumption) the need

to work primarily from women's experience. As a consequence, they are constituted almost entirely by women and they focus on issues essentially from a range of women's perspectives. This trend has been paralleled by the formation of a wide range of other social action groups focussing on women's issues and based in women's experience; for example: women's equal opportunity networks in workplaces; sexual assault support and lobby groups. The formation of these groups has arisen out of a recognition that males and females differ markedly in many of the ways they experience and interact with the social and natural world, and the ways in which the validation and acceptance of male experiences and social processes by society has produced advantages for men over women, a concept which is embodied in the term 'patriarchy'. Women-only groups have been used to validate, explore and extend the ways females experience the world and interact with others, without the requirement for continual reference to the needs of men (in the group or in society generally). In this way, women's issue groups have been free of the raw experience of many mixed groups in which the few men present have taken over the discussion, redefining women's experiences in terms of their own male point of view, or offering paternalistic comment, advice and assistance[4].

The formation and success of gender-inclusive groups, based in females' experience and with predominantly female constituents, raises both practical and philosophical issues about the relationship of men to these groups and the issues they address. Some of the issues apply to the general situation of female-based groups. Other issues relate specifically to female-based groups that address questions about science and science education. Amongst the issues arising out of female-based groups that focus on science and science education, those outlined in the table on the next page may be particularly important for men to consider.

EQUITABLE SCIENCE = NEGOTIATING NEW GENDER RELATIONS

Central to the issues that consider the position of men in gender inclusive change are the current power relationships that put men at an advantage over women in society[5]. The gendered inequities in science and science education both contribute to, and arise out of, these unequal power relationships[6]. It is not possible to simply accept that men who have and interest in attaining gender justice should have an equal or equivalent voice to women in the transformation of social relationships to more gender-inclusive relationships and practices. Feminist analysis and research has confirmed the widely differing social experiences of men and women, and the different and unequal ways that the experiences and voices of men and women are validated[7]. It is not possible for men and women to meet with equity and common understanding in open conference to resolve our differences in power and perception. The experiences of most feminist groups in attempting to come to terms with patriarchy, and to integrate men into this process tend to confirm the practical aspects of this conundrum.

General Issues (not confined to science and science education):

Responsibility and Connectedness: Male culture is individualistic and competitive[8]. This has major negative social outcomes; e.g. sexual assault and other violence. Men should take more responsibility for redressing economic and social disadvantages, including those of women, rather than leaving these problems for women to solve[11].

Potential For Change: Men are in most of the positions of power and influence and are therefore able to effect rapid change, or are able to most effectively block change.

Effects of Changes: Most of the changes that will advantage females will also affect males, sometimes in disadvantageous ways. Despite their current position of privilege, males still have a right to have some say in changes that affect them.

Transfer of Male Power: There are dilemmas for men about developing an interest in, and potential to assist in, the transformation of power towards a position of equality for women and men. For example: What benefit, if any, is there for men in such a transformation; and on what basis - ethical, practical and/or political - should men assist in such a transformation? How can men assist the trans-formation of society without also losing power?

Issues Specific To Science and Science Education:

Responsibility: Men have been largely responsible for the development of the current inequitable and destructive practices in science and science education[9,10]. Therefore the majority of men in science and science . education should take on responsibility for the reformation of these practices, rather than leaving the task mostly to women.

Numbers & Opportunities For Change: Men constitute the majority of scientists and science teachers, so any transformation of science and science education will necessarily involve participation by men.

Men As Recipients and Agents of Change: Since most of the scientists and science teachers in the next decade are going to be men, it is important that men have input into reforming the current inequitable gender practices in science and science teaching.

Men's Involvement in the Transformation of Science and Science Education: Men are both the major influence in the construction of current science and science education and the major recipients of benefits that accrue from this male-dominated construction. Men have dilemma's in how to recognize the ways that science is a male construction and in how to best be involved in its transformation from a male-dominated field of endeavour.

On the other hand, it is not sufficient either for men to leave to women the transformation of science into an equitable discipline, for several reasons. Firstly, men have more power than women in the practice of science and science education, as well as in society in general; in ethical terms, this means that men have a responsibility to act to see that this power is used in ways that enhance equality, and in practical terms it means that men have increased opportunities to bring about these changes. Secondly, decisions that affect the ways in which science and science education are practiced will affect men in major ways; it is ethically important that men are involved in the changes that will affect them, and practically it is important because men constitute the majority of current practitioners of science and science education, and therefore will have an important part to play in its transformation. While men should be involved in, and take some responsibility for, the transformation of science and science education, it cannot be left to men to undertake this important task in isolation from women and women's experience. Some new relationship needs to be found between the outlooks and needs of women for enhancing their social and economic status, and the outlooks and desires of men to assist in this process. What would such a relationship look like? I know of no organization or project in either the practice of science or science education where such a relationship has been overtly achieved (notwithstanding the excellent work of the Union of Concerned Scientists and other groups to bring about changes in the way that science holds power over the institutions and other, non-gender relationships in society). So where do we begin to tackle this issue?

UNDERSTANDING AND TRANSFORMING THE MASCULINITY OF SCIENCE

A significant amount has been written about the gendered relations of science and science education and the extent to which these are 'masculine' disciplines[9,10,12,13]. However, the practical transformation of science and science education to a more gender-inclusive discipline will involve a greater understanding than we have at the moment of the forces that produce and maintain masculinity and the masculine construction of science. While a great deal has been offered to confirm the limiting and destructive tendencies of masculinity in general (including some analysis of the influence of masculinity on the development and implementation of science and technology), it is unfortunate and somewhat surprising that little in-depth analysis has been undertaken of the forces that shape masculinity and the possible ways that a practical transformation of masculinity could be undertaken. There has been a lack of analysis of the whys and hows of masculine socialization, as compared to feminine socialization[14]. Nor have there been any extensive developments in our understandings of the experiences of growing up male. To point this out is not to cry poor: it most probably suggests that, while women have been very interested in developing a comprehensive understanding of what it is to be female and how this leads to disadvantage,

men have not been similarly motivated to develop an equivalent understanding of how we are constructed and what the implications of this are for our societal relations.

One important outcome of the underdevelopment of a sociology of masculinity is that, when groups of men come together to talk through the issues of being male, and to consider what transformations of masculinity and of relationships with women are most appropriate, we are often left foundering in a lack of understanding about where our masculinity has derived from, and what we might have in common when considering what needs to be changed. For example, all of the men's groups in which I have been involved, have struggled over the tension between taking a personal versus a political focus. On the one hand, men are continually confronted with the sad facts that we are not sufficiently in touch with our emotions and that the ways that we lead our lives has a high cost, both for ourselves and for others. For example, in the introduction to the first part of *Men In Difficult Times*[15] it is noted that:

" Mental illnesses occur amongst males with greater frequency than among females. Yet ..... the greatest "madness of men" is their inability to ask for and receive psycotherapy ..... Traditional ideas of masculinity ..... result in the inability of most males to relate to other persons in intense closeness. As a result, men become even more captives of the rigid male stereotypes which lead men to illness, physically and mentally. "

On the other hand, it is important for men to keep in mind that we are the major beneficiaries of the current system of gender relationships and that we have a responsibility to ensure that we are not simply increasing our advantages by coming together to discover ourselves and each other, at the same time denying or ignoring the huge injustices that are daily perpetrated against women. As Bob Lamm pointed out in *For Men Against Sexism* over fifteen years ago[16]:

" We live in a world of men's movements. The ..... government is a men's movement..... Exxon, ITT and General Motors are all men's movements. The American Medical Association and the National Rifle Association are men's movements. Left politics is a series of men's movements ..... Now among all these many men's movements, there is one in particular that I wish to examine. It is the only men's movement which formally calls itself a men's movement. In fact it calls itself *the* men's movement, or the men's liberation movement. ..... When women see a movement of privileged men uniting to talk among themselves and build greater trust *among men*, how do they react? Do they feel hopeful; do they believe that "men's liberation" will lead to positive changes in women's lives? Or do they feel a little worried - having experienced all too well the politics and power of many other men's movements run by men of similar privilege? "

Our lack of knowledge and understanding of the construction and potential for transformation of masculinity impacts on the potential for transforming science and science education into more equitable disciplines. For example, we need to understand more about how men relate to the notions of "objectivity" and "rationality" that have traditionally been promoted as the cornerstones of science. The analyses of how masculinity affects science have so far had little practical impact on the vast majority of scientific pursuits, except where they have come into direct and obvious conflict with the needs of the recipients of particular disciplines of science; e.g. in vitro fertilization; childbirth; chemical contraception. We also have a very underdeveloped understanding about how men in science and science education departments can change themselves and their relationships with other men and women in ways that will promote equity.

I believe it is important for male scientists and science teachers to come together on a consistent, developmental basis to discuss how our pursuits of science interact with our masculinity, in an attempt to understand and transform this interaction so that we can meaningfully contribute to the development of an equitable and caring science. These meetings of men will need to work in conjunction with women involved in parallel attempts to transform science. The relationship between the male and female representatives needs to be clearly delineated in terms of feminist principles. In other areas of changing gender relations there are examples that we can draw on to assist us to understand what such initiatives might look like and what directions they might take.

POTENTIAL FOR CHANGE: WHAT WE CAN LEARN FROM OTHER GROUPS

In equal opportunity and affirmative action programs, and programs that address sexual assault and sexual harassment, groups of men have been involved in working for change, in ways that come to terms with similar issues to those outlined above. In these areas women's groups have a depth of experience in identifying the gender biases, and in working personally and politically for change, with some degree of success. What can we learn from the groups of men who have attempted to develop effective working relationship to the women's groups that focus on these issues?

Men Against Sexual Assault (MASA): MASA formed by a combination of men involved in previous political and personal development groups for men in Melbourne and individual men who were associated with women's groups attempting to reform the laws and practices that surround sexual assault. MASA has revitalized pro-feminist action by men in Melbourne, because it has a specific political focus that is clearly pro-feminist, and one which is seen widely as a legitimate concern of men. MASA has developed a responsible and accountable relationship with appropriate women's organizations. Similar groups have also formed in

other OECD countries[17]. The political and social activities of MASA[18] focus attention on the problems of sexual assault perpetrated by men on women, children and some other men in our society. The men in MASA are acting from a sense of responsibility that is felt by many men to put an end to sexual violence. It has been important for MASA that the activities and perspectives it promotes are agreed to by parallel women's groups acting to eliminate sexual assault. It has also been important for the men of MASA to come to terms, personally and politically, with what it means to be male in society, to examine how our current relationships and interactions with others give rise to the violence and domination.

Equal Opportunity Workshops Run By Men: A group of men from MASA took responsibility for developing workshops that explored the implications for men of equal opportunity policy and legislation in the workplace, and also ensured that the workshop discussion and outcomes should directly address issues of concern to women. Draft workshop formats were developed by men and modified, after discussion with the female equal opportunity representatives. General guidelines for discussion were also agreed to; in particular, it was clarified, especially which aspects of E.O. were clearly non-negotiable and which aspects fell into the grey area of current debate[19]. The workshops were run by men in several sessions. The outcomes of each session were summarized, and female E.O. representatives invited to comment on the outcomes. In one case, a pamphlet explaining the E.O. policy and its implications to men was drafted and circulated to male and female groups; a final format was agreed to and released for general use[20].

Patriarch Awareness Workshop: These workshops are planned and run by men, for groups of men. They are based on those used in racism awareness workshops, in which those with advantage attempt to come to terms with their position and what they can do to redress inequities that arise from this. The planning of the workshops are undertaken in consultation with representative women. Two women act as monitors of the workshop, and are invited to interrupt the workshop if they felt that some point needed to be clarified or countered. They also provided a summary women's point of view at the end of each session. The outcome has been a positive process for both groups, with men feeling a deepened awareness of women's circumstances and how men can assist to change these, and women feeling a greater sense of support and understanding from men.

A PROPOSAL FOR GASAT

I believe that GASAT might be one forum in which the relationships between men and women involved in the process of transformation of science and science education can be clarified. New directions should encourage men to see that we have a responsibility to take action, based on the

recognition that men have advantages over women in society. We should also ensure that men taking action also work within a process of accountability and negotiation with women's groups.

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A SCIENCE CENTER TO SERVE THE MISSING HALF

AnnMarie Israelsson

Les centres des sciences du monde entier sont habituellement le terrain de jeux de garçons de tout âge. Les sciences qui y sont présentées sont des sciences d'hommes et la façon dont elles sont communiquées est, dans la plupart des cas, très masculine, divisant la réalité en événements et principes et omettant ainsi de former une véritable représentation de ce que nous pouvons observer autour de nous.

Ainsi, les femmes qui visitent les centres des sciences sont souvent des compagnes passives de fils, de maris ou d'étudiants, plutôt que des participantes actives dans le processus de communication. Toutefois, les sciences et la technologie sont aussi importantes dans la vie des femmes que dans la vie des hommes. Par conséquent, les centres des sciences devraient également servir les femmes, qui sont ici, sans l'ombre d'un doute, la moitié manquante, comme elles le sont dans d'autres institutions scientifiques et de technologie.

Ce document traite d'une nouvelle approche à la communication des sciences et de la technologie dans les centres des sciences, qui permettrait de s'assurer que ces institutions répondent de façon plus adéquate aux besoins non seulement des femmes, mais de la société en général. Le fait de prendre, pour commencer, les sciences et la technologie pertinentes à la région et d'introduire ensuite les activités visant à faire participer non seulement les adolescentes, mais aussi les femmes, permettrait de modifier le rôle des centres des sciences. Des exemples de Teknikens Hus/The House of Technology (La maison de la technologie), à Lulea, en Suède, démontrent de tels efforts visant à utiliser les centres des sciences différemment, sensibilisant ainsi les gens à l'importance des sciences et de la technologie pour les femmes.

A SCIENCE CENTER TO SERVE THE MISSING HALF

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ABSTRACT

Science centers everywhere in the world tend to be the playgrounds of boys of all ages. The science presented is the science of men, and the way in which science is communicated is in most cases very masculine, splitting reality into events and principles and thus failing to form a true representation of what we see around us.

As a result, female visitors to science centers will remain passive companions of sons, husbands or male students rather than active participants in the communication process. But science and technology are as important to women´s lives to-day as to men´s. Consequently science centers should also serve women, who are so far the missing half here as well as in other institutions of science and technology.

This paper will discuss a new approach to communicating science and technology in science centers generally in order to make these institutions better answer to the needs of not only women but also of society as a whole. Taking the locally relevant science and technology for a starting point, and introducing activities to involve not only young girls but also adult women would change the role of science centers. Examples from Teknikens Hus /The House of Technology/ in Luleå, Sweden, will show such efforts at using a science center differently, thus promoting a new awareness of the importance of science and technology among women.

INTRODUCTION

Tradition and male power have made science and technology a men´s only domain, in almost every manifestation of social life. Even those institutions who take pride in being untraditional in other respects, are victims of tradition if viewed in a gender perspective. This is true of most of the existing science centers in the world.

Science centers have developed out of the science museums, not like these to put up mere objects on display, but to function as three-dimensional catalogues of scientific principles, using the taxonomy that has long been used in science museums and in school to separate

theory from reality. Here the visitor can wander around, use the ready-made experiments, often easily recognizable from the physics text-books of school, only glossier and more sophisticated, and find that they invariably confirm the theory they were set up to prove. Science centers consider themselves innovative and new, but they are organized by men and they will in most cases only paraphrase the old male ways of teaching science.

It is discouraging that among the new science centers started in many countries, and not least in the developing countries, the same contents and the same organizational pattern seem to be prevalent. Female technology and female perspectives on the development of science and technology are largely non-existent in the science centers of the world. Science centers do not seem conscious of the fact that women form a large body of users of technology, and often actually work very closely with technology, though in a different way as compared to men.

Large sums are devoted to funding of science centers, old and new, and yet only half the population is being served. Despite the fact that many women work in science centers, these institutions still remain the playgrounds of men of all ages. To counteract this, women must take a more active part in the setting up of new science centers all over the world and the existing science centers must be put to the use of women.

1 THE SCIENCE CENTER CONCEPT

Top-down or bottom-up?

During recent years the science center concept as such has been the object of discussions among museologists,and science center staff. What is the real task of science centers in the communication of science and technology and how should this task be fulfilled? At a conference on public understanding of science and technology in Madrid in 1991, two science center workers and museologists, Drew Anne Wake and James M Bradburne, presented a critical view on the mission of science centers based on their experiences from working with the Alberta Science Foundation in Canada (1).

Bradburn and Wake contest the top-down idea which is the cornerstone of most science centers: the path to scientific knowledge is laid out by those elect, "the ordained scientists",

who have the right to produce knowledge in schoolrooms, universities and laboratories and to distribute it to the ignorant people. Science literacy is defined as knowledge acquired by students - or science center visitors - to meet the standards set up by the scientific community, regardless of who needs the knowledge and why.

An entirely different basis for communicating science and technology is laid by Bradburn and Wake. They start by stating that people actually have widely differing interests in and needs for science and technology, depending on their gender and the region in which they live. These differences must be taken into account and be part of any programme for science and technology communication. Another important factor is the experience that people already have, which must be recognized and encouraged as a foundation of a scientific and technological culture. This experience should be used to enrich the communication of science and technology and to ensure that the knowledge acquired - in science centres and at school - is relevant to the situation of the individual. As a result, it is no longer clear that the sole legitimate producer of scientific and technical knowledge is the white-coated male scientist. Scientific and technical knowledge is also a product of real life.

The traditional male dominated science center is clearly not a good place for this new way of producing knowledge. Should we then stop setting up science centers or is there a way to conceive and organize a science and technology center that would comply with the new ideas?

A female approach

In a round table session at GASAT 6 some of the work was presented that is being done by women to change the science center concept into more of a bottom-up approach (2).

Jayshree Mehta of the Vikram A Sarabhai Community Science Center in Ahmedabad, India, and the female teachers she works with, teach young children from the slums as well as from the middle classes, and adult women in the villages, asking them all to ask their own questions and try to find answers relevant to them. They deal with science and mathematics using material and references which are familiar to these girls and women. In this way a simple and understandable basis for science teaching is created. It is made clear that people

can actually, by adding new knowledge to their own experience also better cope with their own situation and find solutions to their problems and concerns.

Teknikens Hus /The House of Technology/ at Luleå in Sweden is based on the local industrial technology and the everyday home technology in a broad sense. Local technology, which is well-known to the people of the region, is taken for a starting point. From there on the science center seeks to deepen and extend the understanding of technology, introducing scientific concepts and principles only to help explain the well-known reality which remains whole and recognizable. This also links Teknikens Hus closely to the community, making people feel it is "their" science centre, and not just a place from which knowledge is distributed to the ignorant. In the forest technology exhibition, for example, the forest industry worker is the best teacher. Everyday problems, like how to protect yourself from cold in winter, and how different kinds of materials for clothes function to do this, are used as bases for experiments, applying knowledge of physical principles in a usable way.

This bottom-up approach to science and technology is also a female approach, a way of making women feel certain that science and technology have to do with their own real world and thus are really worth a lot of attention. It is disappointing that the majority of science centers in the world so far stay on the path of tradition, which does not lead to a better and deeper understanding of science and technology and its implications but is in many ways not only uninteresting but even intimidating to female citizens. In my view it is imperative that women be given and take a greater part in the planning and organizing of science centers to change the pattern and approach of the representation of science and technology - to the benefit of visitors of both sexes!

2 SCIENCE CENTERS AT A CROSSROADS

Dinosaurs are dynamite!

Science centers all over the world attract big audiences, especially when they first open. But once the first enthusiasm after the opening year is gone, and visitor numbers decrease, science centers have to decide which way to go to justify - and finance - their existence. Many of them then add spectacular attractions that have little or nothing to do with science. The Japanese robotized dinosaur show has been touring the science centers of the world, scaring

visitors with roaring sounds and moving heads and tails. The omnimax theatres in science centers thrill big audiences with spectacular movies of space adventures of astronauts and concerts by The Rolling Stones - and very little science. These science centers are the victims of what could be termed the amusement park syndrome. Science has to be fun, above all.

These science centers care more for entertainment than enlightenment. It is of course clear that the need for the science center itself to be financially sustained is in part behind this. But, science center directors and board members also want to believe that by adding attractions such as the above mentioned, they will attract visitors who will stroll through the exhibits while waiting for the show to start and so get excited about "real" science. This might happen, but relying on these accidental occasions for communicating science to people puts science itself in a rather strange situation, especially considering the way in which science is normally presented in the science center itself. The exhibits of the science center are never as fun as the dinosaur show, and only those who are already interested can avoid being bored.

But, instead of focusing on an interest in science and technology arising from the needs of the people, science center staff are counting heads at the entrance door and counting money earned by selling souvenirs or tickets for the spectacular shows.

A focal point for the missing half

But what then should be the future role of science centers?

It is clear from surveys in science centers all over the world that the average adult science center visitor is also the ordinary museum-goer, a middle to upper class academic person, mostly male (only art museums attract mostly female visitors), and his family (3). Other visitors may occasionally come to the science center to see very special exhibits, like the dinosaur show, but would not consider visiting the science center regularly.

Female visitors would normally come as companions of sons and husbands or as teachers on a school visit. They do not see the science center as a source of new knowledge to them, because they do not see themselves as interested in science and technology as such. But being asked about environmental issues, or the local city planning, they will show a lot of interest.

They will have a lot to say about practical kitchen gear, and they will have suggestions for new inventions for everyday use but be sceptical about unnecessary technology.

And it is in the interest of these female visitors that I can see a new role for science centers, indeed a different role, more corresponding to all visitors´ needs for deepened and extended knowledge, be they male or female.

Just like the little activity centers that Bradburne and Wake saw emerge in the vast rural communities of Alberta, every science center can be the focal point for the missing half, and in fact for all those who are concerned with issues of different kinds that will somehow relate to science and technology and its implications. In the small communities, a science center can be a community center with a science and technology touch, collecting ideas on development and working with those issues which the citizens themselves are concerned about and want to engage in. In the big city the science center can be the informal educational institution working for new development by integrating science, technology and society in a way that school will not be able to and that will teach citizens to use their knowledge and experience to solve their own problems. It goes without saying that women are even more important than men in this context.

Two examples

So what kind of action can a science center take to start serving the women? Two pieces of experience from my own institution, Teknikens Hus at Luleå, may serve as examples of activities.

1 The city administration of Luleå has a cleaning and janitorial staff of close to 400, mostly women over the age of 30. Most of them have only basic education but much experience from working with their hands. However, they usually don´t handle the bigger technical equipment used in the cleaning work, and so this is left to men, who work more easily and comfortably using these appliances - and get more pay for their work, because it is regarded as technical.

Teknikens Hus has for some time been teaching female teachers to teach everyday technology. When asked by the city administration to take an active part in the professional development of the cleaning staff we gladly accepted this new challenge.

The female educators of Teknikens Hus developed one-day courses at the science center for groups of 10 - 15 women, teaching them to handle everyday technology, like changing fuses, rinsing sewage pipes, changing tap washers etc or doing minor car repairs such as changing wheels or windshield wipers or even spark-plugs. The goals we set were not primarily to make the women do these repairs or services in their jobs but to make them feel confident they could handle technology and capable of gradually changing their work situation by widening the scope of working tasks.

The initial scepticism among the women as to the use of the course and their reluctance to technology was in one day turned into enthusiasm and joy. According to their judgment at the end of the course they felt that everyday technology now was something they could master and not a male concern only. They felt they could also better cope with their job situation, use the technical appliances more often and more independently and make their jobs more interesting and less physically exhausting.

2 Swedish administrative regions are not as independent as states of the United States or provinces of Canada. The governor of the region, however, who is appointed by the central national government, usually plays an important role as a spokesman for the population to express to the government their ideas and concerns for the economical and cultural development of the region. As everywhere else in the world, local and regional politicians and decision-makers in our region are mostly male. The concerns of women have very little voice and are thus not really taken into account when guidelines are set for regional action.

In 1992, a new governor was appointed for the region of Norrbotten, of which Luleå is the capital. Shortly after his coming into office, Teknikens Hus arranged a public hearing of the new governor, who was invited to the science center to listen to

presentations by women representing different activities and concerns and to discuss the future of the region from a female point of view. One hundred women from all the counties of the region were present at the hearing, where the governor was the only male. Women from the minority Lapp people voiced their concern for their indigenous culture and language, young women took the floor to express their ideas about the future of women in the region, environmental issues were brought up and male technology was scrutinized. The hearing was extensively covered in the regional and local media, which also made women´s issues more public.

When the female participants returned to their home communities, they had also formed small groups to carry on activities locally. The governor has since on many occasions referred to his experience from the hearing and has set up a special commission within the regional administration to take care of women´s issues.

These two accounts of new ways of serving the female half of the population on the part of a science center are only examples of what could be a new path of action for science centers generally. The women involved in these activities would not naturally come to the science center out of interest in science and technology. They are now convinced, however, that the existence of the science center can contribute to society not only in the sphere of science and technology but in a much broader sense.

CONCLUSIONS

The role of science centers in society must be seen in a broader context. A discussion of the organization, the role and the scope of science centers should be on the agenda of feminist science, for a number of reasons.

Science centers are visited by large amounts of citizens all over the world. They are a powerful medium, and the message they convey influences children from an early age. They are often considered the front institutions in teaching science and technology for the modern world. But many of the female visitors to science centers - mothers, daughters, sisters,

wives, teachers with their classes - still do not feel that science and technology are their concern.

As long as science centers keep the male mechanistic concept of science and technology, and fail to relate to people´s own reality, they will not bring about any change in science and technology education or in science itself. They will go on serving only the male half of the population and dealing with their technology.

Women everywhere must be more aware of the power of science centers and more critical of the way they work. Science centers should not be left the playgrounds of boys or institutions for male culture only, they should be used by women for women. Their cultural implications all over the world must be realized, and feminist scientists and educators must take a voice to discuss the educational mission and methods of science centers.

We should let the Walt Disney people manage the amusement parks, and insist upon making science centers working educational institutions of modern culture. They should be turned into meeting-points for everybody, points where knowledge and practical experience unite to shape the technology of our world and to serve the whole of humanity.

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CREATING A MORE INVITING CLIMATE AND DEVELOPING STRATEGIES FOR CHANGE

Victoria A. Kazinja

Dans un monde moderne où les femmes tentent d'obtenir l'égalité avec les hommes, il reste encore beaucoup à faire pour promouvoir le rôle des femmes dans le domaine des sciences et de la technologie, comme dans celui de la prise de décisions. Ce document traite des stratégies à mettre en oeuvre au sein de la cellule familiale et dans le pays pour favoriser un climat propice au développement des femmes dans la société. Il décrit également quelques modèles à imiter de leaders féminins qui ont prouvé que les femmes étaient vraiment capables.

Le document de recherche est disponible auprès de l'auteure.

CREATING A MORE INVITING CLIMATE AND DEVELOPING STRATEGIES FOR CHANGE

Victoria A. Kazinja, (P.G. Diploma), Wri, Tanzania

In a modern world where women are trying to achieve equity with men, much has to be done to create a supporting environment to promote female roles in science and technology, and also in decision making. This paper discusses the strategies to be put forward by both family and nationally to bring an inviting climate for women's development in society. It also illustrates some model roles of women leaders who really proved that women are capable.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

L'INGÉNIERIE POUR LES FEMMES

Françoise Marchand, Manon Côté et Michel Galopin

As a University School of Engineering, the École de technologie supérieure (ETS) is already involved in various ways and has committed itself to work towards increasing the number of women in engineering.

Introducing this new Montréal Engineering Institution, we will emphasize the features which set it apart. We note that the current political decision stream actively supports the greater presence of women in key jobs within our society. Having described the actual situation at the ETS, we will take stock of the incentive mechanisms which already stand or are being contemplated.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

L'INGÉNIERIE POUR LES FEMMES

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RÉSUMÉ

En tant qu'institution universitaire en ingénierie, l'École de technologie supérieure (ÉTS) est déjà impliquée de diverses manières et veut s'engager davantage en vue d'augmenter le nombre de femmes en génie.
Nous présentons cette nouvelle école montréalaise de génie et nous soulignons les caractéristiques qui la distinguent. Nous constatons ensuite que le courant décisionnel politique actuel désire augmenter la présence des femmes dans les postes-clefs de la société. Après avoir décrit la situation présente à l'ÉTS, nous faisons l'inventaire des mécanismes d'incitation déjà en place ou projetés.

INTRODUCTION

L'ingénieur exerce une profession intéressante, accomplit un travail enthousiasmant et diversifié, relève des défis, tout en s'assurant une aisance économique. L'ingénieur d'aujourd'hui participe à la vertigineuse évolution technologique, caractéristique de cette fin de siècle. L'ingénieur est le professionnel «des solutions technologiques permettant d'améliorer la qualité de la vie.» [1]

Comment alors expliquer le peu de participation des femmes à cette profession ?

- En 1990, moins de 5% des ingénieurs professionnels du Québec sont des femmes (moins de 4% au Canada). [1]
- Diplômes en génie décernés à des femmes au Canada: 3% en 1975 et 13% en 1989. [5]

Que faire pour augmenter la participation et la présence des femmes en ingénierie? Quels actes concrets poser pour faire évoluer la situation en ce sens ?

Plusieurs études ont tenté d'apporter des réponses à la première question. Dans certains cas, on blâme la société qui détourne les filles des carrières scientifiques. Ailleurs, on reproche aux facultés d'ingénierie de ne pas offrir à ses étudiantes potentielles un milieu accueillant. Enfin, on souligne la discrimination à l'égard des femmes ingénieurs

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pratiquée dans le milieu de travail. Cet article n'approfondira pas la recherche des causes de ce phénomène. Notre objectif est tout autre: augmenter le nombre de femmes ingénieurs par des actions concrètes dans notre milieu de travail. En tant qu'institution universitaire, l'ÉTS doit assumer un rôle important dans la quête de cet objectif.

Après présentation de l'École, nous ferons état du courant décisionnel politique actuel qui favorise une présence accrue des femmes. Nous décrirons la situation à l'ÉTS et finirons par la description des mécanismes d'incitation présentement en cours dans cette institution.

ÉCOLE DE TECHNOLOGIE SUPÉRIEURE

Créée en 1974, l'ÉTS a deux objectifs majeurs que sont l'enseignement supérieur et la recherche en ingénierie. Ses quatre programmes de baccalauréat en génie (construction, production automatisée, mécanique et électrique) et sa maîtrise, orientés vers le génie d'application autant par son type d'enseignement que par l'adoption de l'enseignement coopératif[1], confèrent à l'ÉTS une collaboration avec le milieu industriel québécois. Ses programmes ont été accrédités par le Bureau canadien d'accréditation des programmes d'ingénierie (BCAPI) en juin 1990, permettant ainsi à ses diplômés d'être directement admissibles à l'Ordre des ingénieurs du Québec (OIQ). L'ÉTS accueille actuellement 2100 étudiants (hiver 1993) à temps plein et à temps partiel. L'École étant le seul établissement universitaire québécois à s'adresser spécifiquement aux personnes détentrices d'un diplôme d'études collégiales en techniques physiques[2] et informatique, ses programmes offrent donc la possibilité d'une continuité à la formation technique reçue dans les cégeps (Collège d'enseignement général et professionnel, incluant ci-après également les Collèges privés) (cf. Tableau 1). La population étudiante féminine de l'ÉTS est donc tributaire de la population étudiante féminine des cégeps dans les secteurs admissibles à l'ÉTS, soit les techniques physiques et informatique. Actuellement, parmi les étudiantes de l'ensemble des cégeps, seulement 5% fréquentent le secteur technique [4].

Quatrième établissement universitaire d'ingénierie à voir le jour dans la région montréalaise, l'ÉTS est le deuxième de langue française.[3] Ajoutons immédiatement que les profils d'accueil de ces deux établissements francophones diffèrent. En effet, bien que les deux établissements accueillent des personnes détentrices d'un diplôme d'études collégiales (D.E.C.), l'ÉTS s'adresse uniquement aux personnes détentrices d'un D.E.C. technique, donc professionnel (cégeP: 40% de la population étudiante de tous les cégeps

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1 Les étudiants et les étudiantes complètent donc trois stages de quatre mois en milieu industriel.

2 Quelques exemples de techniques physiques : génie civil, technologie de l'architecture, électronique, avionique, équipement motorisé, technologie physique, procédés métallurgiques.

3 Il y a deux universités et sept facultés de génie dans l'ensemble du Québec.

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[9]), alors que l'autre établissement s'adresse aux personnes détentrices d'un D.E.C. en sciences pures, provenant donc du secteur général (céGep: 60% de la population étudiante de tous les cégeps [9]). En 1986, le pourcentage d'étudiantes dans les disciplines de sciences pures et appliquées et sciences de la santé (céGep) était de 29% alors que pour les hommes, il était de 43% [7]. Dans le secteur technique, rappelons-le, la proportion des femmes inscrites est encore plus faible (5%). Par ailleurs, une plus grande diversité de programmes de génie est offerte aux étudiants du secteur général et comprend notamment les génies chimique et industriel, deux branches de génie où les femmes ont tendance à se diriger en proportion plus élevée. Il est à noter que l'ÉTS ne les offre pas.

TABLEAU 1. COMPARAISON DES SYSTEMES SCOLAIRES EN INGÉNIERIE: CANADIEN ET QUÉBÉCOIS[1] [8]

	Primaire et secondaire	Coll.of applied Arts & Comm. Coll.[2]	Cégep	Université Baccalauréat (ingénierie)
Canada	11 ou 12 ans	variable: de quelques sessions à 1 an	—	4 ou 5 ans
Québec	11 ans	—	2 ans: D.E.C. en Sc. pures	4 ans
ÉTS	idem	—	3 ans: D.E.C. en technique	3½ ans

COURANT DÉCISIONNEL POLITIQUE FAVORABLE

Dans différents paliers de la société, il y a un mouvement qui se fait actuellement dans la même direction: on veut reconnaître et faciliter l'égalité des femmes au travail, tant du point de vue des carrières entreprises que du salaire. Cette volonté se manifeste de diverses façons, entre autres, en encourageant les femmes à poursuivre des carrières en sciences et en ingénierie.

Participant à ce mouvement, on retrouve les gouvernements provinciaux et fédéral et certains ministères et organismes «le Conseil des sciences du Canada», «la Condition féminine du Canada», «le Conseil des ministres de l'Éducation», «l'Association des universités et collèges du Canada». On compte également les associations professionnelles; les entreprises et le milieu des affaires; les milieux d'éducation.

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1 Description générale seulement qui ne fait pas référence à toutes les éventualités.
2 Comparable au secondaire professionnel et au collégial technique au Québec.

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On assiste actuellement à un changement prononcé dans l'image de la société, véhiculée par ces divers représentants du pouvoir, changement dont l'intensité était presqu'imprévisible il y a tout juste cinq ans. Parmi de nombreux cas concrets reliés au monde traditionnellement masculin de l'ingénierie, citons quelques exemples. Dans le document des «Études supérieures en génie au Canada» édition 1992 [6], des photos représentent soit les campus universitaires, soit des étudiants, en groupe ou individuellement. Il est intéressant de souligner que les universités font un réel effort pour encourager leurs étudiantes potentielles à s'inscrire à leurs programmes en leur démontrant que les femmes font déjà partie du monde universitaire. En effet, sur les 11 photos illustrant des groupes d'étudiants, 7 comprennent des femmes (64%). Pour les photos d'étudiants seuls, 5 photos sur 13 sont des photos de femmes, soit 38%. Évidemment, ces pourcentages ne reflètent aucunement le pourcentage actuel des femmes en ingénierie aux études supérieures, mais illustre bien la volonté des responsables des universités canadiennes de favoriser l'augmentation du nombre d'étudiantes sur leurs campus. Cette volonté se poursuit pour les étudiantes admises dans leurs programmes. En effet, pour les deux établissements universitaires francophones québécois en génie, les pages couvertures des agendas universitaires distribués aux étudiants pour le baccalauréat et pour les études avancées montrent des femmes étudiantes en action. De son côté, une université anglophone, également à Montréal, a réalisé un vidéo sur les femmes et sur les minorités ethniques «En toute égalité» [3] qui a été subventionné par toutes les universités québécoises.

Les associations professionnelles donnent également l'exemple en éduquant la population. En 1991, l'Ordre des ingénieurs du Québec a décidé de présenter un visage plus humain de la profession. Depuis lors, la page couverture du journal «Le PLAN» montre des visages d'ingénieurs: une fois sur trois, ce sont des femmes. Cette proportion, bien sûr, ne correspond pas encore à la réalité. L'OIQ a aussi réalisé un vidéo destiné aux élèves des écoles secondaires qui explique la profession d'ingénieur. Les femmes ingénieurs y sont très bien représentées.

Comment accélérer le changement ?

Un comité a été créé: le «Comité canadien des femmes en ingénierie» (CCFI). Il a déjà organisé des forums et des colloques. Plusieurs recommandations ont été formulées et des échéances pour ces recommandations ont été spécifiées. De plus, des mécanismes de vérification d'application de ces recommandations ont été instaurés.

> **«A long terme la solution la plus efficace consiste à employer plus de femmes pour enseigner l'ingénierie, élaborer le programme d'études en génie et contribuer à développer les connaissances techniques par le biais de la recherche.» [1]**

Objectifs

Parmi les recommandations formulées par le CCFI, voici celles où l'ÉTS peut et doit agir d'ici 1997:

- Atteindre un nombre égal de filles et de garçons, dans les cours de maths et de sciences dans les classes supérieures des écoles secondaires;

- Atteindre dans les facultés de génie, les proportions de 25 à 35% pour les étudiantes de première année au baccalauréat, 18% pour les diplômées des programmes d'ingénierie, 20% pour les étudiantes à la maîtrise et 5% pour le corps professoral.

SITUATION A L'ÉTS: DES FEMMES ET DES CHIFFRES

Le corps professoral

Le nombre de professeurs permanents pour l'année 1993 est de soixante-neuf (69) dont trois (3) femmes, soit 4%. De 1978 à 1993, pour les quatre départements de génie, le pourcentage de chargées de cours (enseignant engagé pour un ou plusieurs cours pour une session) était de 6%. Il est actuellement de 5%. Nous pouvons constater qu'il n'y a pas eu d'évolution remarquable même si nous obtenons une moyenne supérieure à la moyenne canadienne des professeures de faculté en ingénierie à l'automne 1990 (≈2% [1]).

Présence des étudiantes

Voici les pourcentages concernant le nombre d'étudiantes à l'ÉTS depuis 1990, à temps plein et à temps partiel au baccalauréat en génie.

TABLEAU 2. LES ÉTUDIANTES A L'ÉTS

1990	1991	1992	1993 (Session hiver seulement)
3,8%	4,8%	5,7%	6,3%

De 1974 à 1990 la moyenne canadienne des femmes présentes dans les universités en ingénierie passe de 3% à 14%. L'augmentation est donc de moins de 1% par année et est sensiblement la même pour l'ÉTS.

Dans les associations scientifiques de l'ÉTS, les étudiantes sont peu nombreuses mais grandement impliquées à toutes les étapes des projets, incluant l'organisation des clubs eux-mêmes. D'ailleurs, la présence d'étudiantes à la direction des clubs confirme que les jeunes femmes s'impliquent réellement et ceci dénote également une acceptation implicite de la part de leurs confrères.

Recherche de stages par les étudiantes

D'après les agents et agentes de stage travaillant à l'ÉTS, les étudiantes n'ont pas plus de difficulté que leurs confrères à se trouver des stages. De plus, le niveau scientifique de leurs stages équivaut à celui des stages des étudiants masculins.

La recherche de stages par les étudiantes est même facilitée par les politiques de discrimination positive exercée par certaines compagnies québécoises qui doivent respecter ou tenter de rejoindre des quotas établis, particulièrement des compagnies ou des organismes "près" des gouvernements, notamment, la Société d'hypothèque du Québec, Société immobilière du Québec, Ministère des transports, Hydro-Québec, General Motors. Certaines compagnies ont même créé des stages supplémentaires pour des étudiantes dont les Curriculum vitae (C.V.) étaient exceptionnels. Évidemment, d'autres compagnies embauchent aussi au mérite, comme la Brasserie Molson où l'étudiant qui a le meilleur C.V. l'emporte, femme ou homme.

En résumé

La situation actuelle à l'ÉTS est loin des objectifs visés par le CCFI pour 1997. Ceci s'explique en partie par la vocation de l'École d'accueillir exclusivement des étudiants qui proviennent des programmes techniques de cégeps (secteur professionnel) où le taux d'étudiantes est particulièrement bas. Cette explication n'excuse pas pour autant la situation. Cependant, le Québec est en avance quant à ses politiques et mesures pour la valorisation des femmes comparativement à l'ensemble du Canada, tels que les congés de maternité et de paternité pour ses employés.

Présentes à l'ÉTS, les femmes professeurs et les étudiantes s'y sentent à l'aise. L'École croit à l'importance d'augmenter leur nombre. Le mouvement est déjà amorcé. Mais que fait-on pour améliorer ce pourcentage ? Quels actes concrets l'ÉTS pose-t-elle ?

MÉCANISMES D'INCITATION A L'ÉTS

L'ÉTS a mis au point un certain nombre de mécanismes visant à augmenter le nombre de femmes en ingénierie. Certains de ces mécanismes touchent l'ÉTS directement

(interne) ou s'adressent aux établissements d'enseignement secondaire et collégial (externe).

INTERNE

Le corps professoral

> « J'aurais vraiment aimé avoir une professeure de génie à l'université. Il y a toute une différence entre le fait de savoir que c'est possible (de devenir ingénieur) et voir que quelqu'un y est réellement parvenu.» [1]

L'ÉTS favorise l'engagement de candidates compétentes qui répondent aux besoins des départements et qui seront un modèle pour les étudiantes. Par contre, ce processus risque d'être assez long puisqu'il n'y avait, en 1987, que 13% des diplômés au baccalauréat qui étaient des femmes. [5]

Les étudiantes

En 1992, quatre (4) bourses étaient disponibles pour les étudiantes et cette année, on en compte onze (11), d'une valeur de 500$ à 1 000$: des bourses industrielles, des bourses d'implication dans la vie étudiante et cinq (5) bourses destinées aux nouvelles étudiantes. Ce chiffre demeure insuffisant puisqu'il ne permet pas la progression rapide souhaitée du nombre de nouvelles étudiantes.

Une rencontre avec les étudiantes de l'École a été organisée en 1990. La prochaine aura lieu en mars 1993. Les objectifs visés: connaître davantage les besoins de notre population d'étudiantes, constituer une liste de celles qui sont intéressées à participer à des conférences dans le cadre du recrutement au secondaire.

Le milieu universitaire

L'ÉTS a mis en application une politique contre le harcèlement sexuel [2]. L'installation d'une garderie pour les étudiants et le personnel de l'École est prévue pour 1994.

EXTERNE

Le recrutement étudiant

L'École organise la tournée des cégeps depuis sa création en 1974 et la tournée des écoles secondaires depuis 1991. Au cours de ces visites, un effort particulier est accordé pour recruter des étudiantes. Des rencontres leur sont spécifiquement destinées.

Pour tous les documents produits par le Service du recrutement, on cherche à utiliser des termes génériques impliquant autant les femmes que les hommes. A noter que ce type de formulation est plus complexe en français qu'en anglais.

Exemples d'interventions:

. **Tournée annuelle** dans les cégeps et écoles secondaires dans le cadre de journées carrières. Présentation avec kiosque et ateliers. Visites de l'ÉTS par les élèves.

. **Publication d'une brochure** destinée spécifiquement aux élèves du secondaire qui s'adressera plus spécialement aux jeunes filles dans un langage et support visuel adéquat.

. **Conférences** dans certaines classes d'"Éducation au choix de carrière", dans des écoles publiques mixtes ou collèges privés pour filles. A cette occasion, une étudiante de l'ÉTS est invitée à relater son expérience.

. Conférences pour le **Projet TNT** (travail non traditionnel). Projets gouvernementaux pour femmes. Candidates adultes.

. Participation au **Salon de la femme en 1992**, à Québec et à Montréal. Présentes: trois (3) étudiantes de génie mécanique. Panel de deux (2) conférencières de l'École, une étudiante et une diplômée sur le marché du travail.

CONCLUSION

Il importe de réitérer l'apport essentiel du CCFI qui a initié la mise en place de balises précises quant aux objectifs à atteindre et à leurs échéances. Depuis la parution de leur rapport en avril 1992, le comité a relancé activement et à maintes reprises, les établissements universitaires. Les doyens devaient répondre à un questionnaire très détaillé portant sur la situation présente de l'École face aux recommandations du CCFI.

Nous proposons les actions suivantes:

1) Pour augmenter le nombre d'étudiantes à l'ÉTS, accroître le nombre de bourses qui leur sont destinées dès la première année. Rappelons que le nombre total de bourses accordées pour les étudiants est de quatre-vingt-cinq (85). La proportion de bourses destinées aux étudiantes devrait être largement augmentée.

2) Pour inciter les jeunes filles du secondaire à poursuivre des études en ingénierie, encourager les étudiantes de l'ÉTS à participer aux rencontres.

3) Afin d'augmenter le nombre de professeures, mieux informer le corps professoral actuel de l'existence de fonds disponibles, créés pour encourager des candidates potentielles à poursuivre des études avancées.

4) Instaurer des procédures d'évaluation des divers mécanismes d'incitation en cours à l'ÉTS.

Cependant, les femmes ont également leur responsabilité dans l'évolution de la société: elles doivent profiter des possibilités offertes et par conséquent en être mieux informées. Bien que certaines embûches demeurent, rien n'empêche les femmes d'accéder à la profession d'ingénieur.

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UGANDA'S EFFORTS TO INCREASE GIRLS'/ WOMEN'S PARTICIPATION IN STM

Jane N. Mulemwa

Comme dans de nombreux pays, l'Ouganda compte peu de femmes dans le secteur des sciences (S), de la technologie (T) et des mathématiques (M). Tant le gouvernement que le peuple de l'Ouganda ont reconnu ce phénomène, et des efforts sont actuellement déployés en vue de remédier à ce problème.

Ce document dresse la liste des principaux facteurs qui freinent la participation des femmes dans le domaine des STM. Il aborde ensuite l'intervention nationale en vue de corriger la situation, par le biais d'efforts gouvernementaux et non-gouvernementaux. Ce document suggère également d'autres stratégies possibles et les contraintes gouvernementales pour les mettre en oeuvre.

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UGANDA'S EFFORTS TO INCREASE GIRLS'/WOMEN'S PARTICIPATION IN STM

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As in many countries, Uganda too, has relatively very few women in the area of science (S), technology (T), and Mathematics (M). Both the government and people of Uganda have recognized this anomaly and efforts are now being made to try and remedy the situation.

The paper will give a background of the major factors inhibiting women's participation in STM. The country's move to redress the situation through both government and non-government efforts will then be discussed. Other feasible strategies will be suggested and the country's constraints in implementing them outlined.

INTRODUCTION

Women world-over, have been discriminated against economically, socially, and educationally on the grounds of sex, (Jensen 1986, Lowe and Hubbard 1986, Ayim *1986),* and particularly so in developing countries (Stromquest *1989,* Ndunda and Munby *1991).* Their great economic contribution through domestic work, child-rearing, and work in the garden and farms is not valued in economic terms and is therefore not remunerated. They are further, traditionally discouraged from engaging in public life as professionals, careerists, employers, employees, politicians or leaders of any significant repute. Consequently, there are relatively very few women in top managerial and/or decision-making positions, particularly in the STM area, in Uganda, as is true elsewhere, even in developed countries (Kahle 1985).

GIRLS' ENROLMENT INTO FORMAL EDUCATION IN UGANDA

Although there is legal equality in education for both sexes, the government cannot provide free education due to financial constraints and therefore, even primary education is not yet universal or compulsory.

There are relatively few places and schools for girls in primary, secondary and tertiary institutions; and where there are financial constraints, as in many homes, parents are likely to send their sons to school in preference to girls. Furthermore, although the disparity in the initial enrolment of boys and girls into primary school

is small, it greatly increases as one moves up the educational hierarchy to primary seven, through secondary and tertiary levels, a situation typical of many developing countries (Stromauist 1986). The reasons for this drastic decrease in enrolment of girls at higher primary and post-primary education include:

The poor academic performance of girls compared to boys, probably due to the fact that much of their home-study time is taken up on doing house-hold chores; the high drop-out rates especially at secondary school level due to pregnancies, early marriages etc., and the fewer places for girls at all post-primary and other tertiary institutions.

GIRLS' PARTICIPATION IN STM

Since girls' enrolment thins out as one moves up the educational hierarchy where STM subjects are studied, it follows therefore that the number of girls initially available to study STM is very small compared to that of boys. The proportion of these girls who pass and qualify for admittance to STM vocational and careers training is even smaller. Consequently, there are very few women in STM-based occupations and careers, not to mention the fact that, of these, again hardly any ever hold top management or decision-making positions. In this aspect, developing countries are similar to developed ones for there too, women are still very poorly represented in the STM field (Brush 1991, Armour 1991).

SOME FACTORS INHIBITING GIRLS' PARTICIPATION IN STM

1. PSYCHOLOGICAL FACTORS

The women themselves tend to shy away from the STM field as being too difficult for them to pursue because they have long been brainwashed into believing that they are academically inferior to men, especially in the STM area. This world-wide inferiority complex (Lowe and Hubbard 1986, Brush 1991) and consequent dislike of, and lack of interest in STM by women, had been bred and nurtured through the negative attitudes, beliefs and practices of society as follows:

a) The Fallacy of the Masculine Nature of STM

Society in general, and teachers and career-guidance counsellors in particular, (mostly male), discourage girls from taking STM subjects with the justification that STM courses are both physically and mentally very demanding and therefore more suited to men. The few girls who dare opt for STM are therefore isolated and branded as 'odd", "eccentric" and are 'feared" or distanced by their male colleagues and society at large. This worldwide fallacy (Brush 1991 & Amour 1991) is unfortunately, consciously or subconsciously upheld by national planners and decision-makers (again mostly men), resulting in the fact that there are very few

or no places at all for girls in STM institutions. For example, out of the 9 halls of residence at **Makerere** University, only 2 are for girls, with a third hall being shared by both sexes.

b) Lack of Job Opportunities
Most employers prefer male to female employees. Consequently, even the few women who qualify in STM end up veins ill-employed, which is quite discouraging to would-be STM women aspirants.

c) Lack of Female Positive Role-Models.
Uganda today can boast of only very few indigenous Ugandan women particularly in the higher echelons in the STM field. For example: Out of a total of 291 academic staff members in all science-based departments of Makerere University, there are todate (Feb. 1993), only 23 females, out of which only about 4 hold Ph.D's. The situation is similar if not worst in many other STM areas.

This absence of positive-role models, is a major barrier to girls' participation in STM because it casts doubt in the minds of girls in particular, and throughout society in general, on women's ability to pursue studies in these areas. It even raises the question of the relevance of STM to a women.

II. SOCIAL-CULTURAL FACTORS
Cultures in Uganda, are such that they discourage and inhibit women from participating in education and the STM field in particular, in various ways.

a) The Early Sex-Role Socialization Process:
The early socialization process is such that even as toddlers, girls are encouraged to play at "mother" and "house-keeping", while the boys are given mechanical toys to play with and manipulate. ~he boys are encouraged to be adventurous, explore, and be brave like their fathers; while the girls are to stay home, be neat and help their mothers with household chores. In this way, a boy's ability for investigational, mechanical and technical manipulations is nurtured very early, while similar potential in a girl is thwarted.

Traditionally, a "good" wife is one who totally supports and obeys her husband without any questions. Consequently, girls are reared to be totally unquestioning and submissive to men. Therefore, girls who have grown up with their intellectual curiosity being discouraged, thwarted and out-right forbidden are not likely to be attracted to STM subjects where there are demands for intellectual curiosity, questioning, investigation, manipulation and critical reasoning. Traditional society

too, would not encourage girls into STM area because then, they are less likely to be "good", unquestioning wives.

b) Early Marriages

Since society expects girls to marry at an early age, STM courses and careers which require relatively long programs of education, are detrimental to girls, opportunities on the marriage market; and therefore the girls avoid them, often with the support and encouragement of their relatives and friends.

Furthermore, when girls marry early, at around 16 years, they invariably drop out of school. It is then almost certain that they would never get access to higher level education, and therefore STM education, firstly because it is almost impossible to gain re-entry into the formal system once one withdraws; and secondly, not only is it very difficult to combine formal education with family responsibilities, but many husbands are reluctant to allow their wives to resume formal education. c)

Maturation

The process of maturation presents a psychologically very disturbing period in a girl's life because of the sudden and drastic physiological changes such as breast-enlargement and menstruation which occur at this time. The "little girl" becomes a Woman" overnight and suddenly, society begins to constantly remind her of her natural child-bearing capacity, role and duty. Perhaps more important is the regrettable fact that sexual harassment, in all its many forms, also starts at about this time.

Unfortunately, all these changes occur at the critical time, when STM subjects are being seriously introduced. Since a girl's attention at this time is focused on the strange changes going on in her body and on society~s social attitude and expectations towards her, her concentration on her studies, especially the relatively new STM subjects, is bound to be adversely affected. The girls therefore tend to opt for the more familiar, non-STM subjects. The factor of sexual harassment has also been identified in other countries (Brush 1991).

III. THE POOR SOCIAL-ECONOMIC STATUS OF PARENTS

In Uganda, the social-economic status of most people is very poor compared to their social-welfare requirements of food, shelter, clothing, health and education. Furthermore, there is still the tendency of having large nuclear and extended families. Therefore, parents are often not in a position to afford the formal education of all their children and relatives. In the face of financial constraints, parents prefer to educate boys rather than girls because of the belief that, even if

the girl did complete school, she will get married into someone else's family and hence not be as useful to her family as a boy, later on. Consequently, only a few girls ever get post-primary and therefore STM education.

IV. THE NATURE OF STM SUBJECTS

The nature of STM is such that it is time-consuming, intellectually very demanding, and often mathematical. These brain-exacting, abstract, and relatively "new" and therefore "very difficult" subjects~ are unfortunately introduced at a time when a girl is involved more in beautifying, composing and behaving herself into the "woman" that society expects her to be. The girls therefore, tend to opt for the more familiar and therefore "easier" non-STM subjects.

It should however be noted that, the few girls who do engage in STM studies tend to do as well as, if not better than a big proportion of their male colleagues.

STRATEGIES FOR INCREASING WOMEN'S PARTICIPATION IN STM

1. STM Policy

Having recognized the need for national STM capacity-building, the government created a new Ministry of "Science and Technology." This ministry is currently in the process of evolving and developing STM policies aimed at elevating the scientific and technological level of the nation. The policies are being evolved with the participation of national experts including women. The Deputy Minister of this ministry, for example, was a woman till last year when she was moved to another ministry. Although it is not yet a policy, science is now becoming a compulsory subject up to senior 4 level.

2. A Positive Political Climate

The current political climate is the best Uganda has had for a long time for national development. Furthermore, with regard to women, government has shown very good will and has, for the first time, come out very strongly to support and consciously help women to participate in development. It for example, created a ministry for women's affairs called the Ministry of Women in Development." This supportive political climate is encouraging the building of educational institutions among many other things. For instance, the privately sponsored "Islamic University of Uganda" is now three years old and offers sciences and science-education, while another university is due to start in 1993.

3. Institutional Building

There is active encouragement and participation of Government in the building, rehabilitation and equipping of schools and other educational institutions. For example, two years ago the government started a university specifically for the STM field, known as the "University of Science and Technology".

4. Affirmative Action

Available data indicate that women's participation in higher education and national development was so low that government resorted to "affirmative action" or "temporary positive discrimination". Such strategies are aimed at fast producing the badly needed positive female role-models particularly in the STM area, for this does encourage girls participation (Armour 1991). Below are some examples of actions taken.

a) Female university-aspirants who have obtained the minimum aggregate points for entry to the university, have an extra 1.5 marks added so that they stand a better chance of making the aggregate required for the professional and science-based courses. This temporary measure seems to have had the desired effect as indicated in the table below for science women admissions to Makerere University.

	Admission without 1.5	Admission with the 1.5	Beneficiaries	
1990/91	97	130	33	34%
1991/92	105	167	62	57%

b) Well qualified women in all fields, STM included, are being sought out and if suitable, appointed to appropriate managerial and decision making positions; for example, the Ministers of "Agriculture, Animal Husbandry and Fisheries", and of "Women in Development" are both women, as is the Director of the newly formed "National Bureau of Standards".

c) Makerere University has launched a degree program in "Women's Studies". One of the courses in this program is "Women In Science And Technology"

5. Popularization of Science

All government ministries and agencies and NGO's are encouraged to develop programs for bringing STM to the public through mass media and other media like mobile video shows, theatre, and drama. The national radio and television now have specific science education programs many of which feature girls and women. Efforts are being made to re-introduce and strengthen career-guidance services in schools.

6. Cultural Re-orientation

Government has a serious campaign to increase public awareness about the vital need to involve women in all aspects of national development, with particular emphasis in the STM area. Society is being consciously urged to do away with all those social-cultural biases, traditions and practices that impede women's participation in education and all aspect of national development particularly in the STM field.

7. Other Efforts

As stated above, the current political climate and good will is the best Uganda has had for deliberate encouragement of women to participate in STM fields as well as in all other areas of development. Therefore, many non-government organizations and individuals, are doing research and mounting programs for girls and women. For example, the Uganda Association of University Women, (UAUM), has an on-going career-guidance program for girls at secondary level with emphasis in the STM field. We organize workshops for career-guidance teachers as well as talks given to girls by successful women in this field. There is also participated in a national project, the STME Project, aimed at encouraging more girls into this area. In July 1992, we had a national three-day workshop in which secondary school girls had discussions and shared experiences with a wide variety of indigenous Ugandan women in the STM field.

CONCLUSION

In this paper I have addressed some of the major factors that I believe to be inhibiting women from participating in the STM field. I have briefly outlined some of the strategies that are currently being employed in an attempt to re-address the situation, deliberately leaving out other feasible short and long term strategies. For instance, the present system of education in Uganda emphasizes the formal "youth" education and yet women often have to withdraw from formal education for the period of motherhood. The youthful years also happen to be, biologically, physiologically, and psychologically, the best childbearing years; and those girls who opt for education at this stage, take the risk of being too old to bear children. Therefore, if the majority of women are to acquire maximum benefit from education, a system of re-current education, which takes cognizance of the fact that women's educational needs are generally shifted from "youth" to "adult" life, must be developed. Similarly, the career planning and labor ethos would need to be drastically modified so as to allow for the "late" adult entry into the employment sector.

In the meantime, however, one of the greatest challenges facing Ugandans, is how to help women overcome a life-long entrenched inferiority complex, so that they actively participate in education in general and STM education and careers in particular.

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DEVELOPING A FEMINIST PERSPECTIVE ON SCIENCE THAT RECOGNIZES THE DIVERSITY OF EXPERIENCES OF WOMEN, GIRLS AND INDIGENOUS PEOPLE

Jayantee Naugah

De nos jours, nous insistons sur un enseignement des sciences pour toutes et pour tous. Il semble pourtant évident que les femmes sont quelque peu délaissées. Par exemple, on parle peu des distinctions faites entre les sexes dans la présentation des concepts scientifiques faisant que les filles abandonnent les sciences après le niveau d'études secondaires, se fermant ainsi les portes à une carrière dans les sciences. Toutefois, lorsque ces mêmes femmes participent au développement industriel de leur pays, il est essentiel qu'elles soient scientifiquement compétentes.

Les sciences apprises doivent être pertinentes et répondre aux besoins immédiats des jeunes filles, des femmes et des indigènes. Cet enseignement pourrait inclure des sujets ou objets familiers qui permettent de mieux comprendre les principes scientifiques qui entourent les sciences. Les éléments de l'éducation à la santé, des maladies, de la sécurité, de l'électricité résidentielle, et de l'anatomie et de la physiologie de base permettront de mettre de côté certaines vieilles habitudes et coutumes bien ancrées et de mieux vivre.

Les femmes des pays en voie de développement connaissent peu les sciences relatives à la cuisine; elles ignorent les concepts mêmes d'une alimentation équilibrée, de l'hygiène et des soins maternels. Côté santé, le SIDA pose un grave problème. Les femmes ont un important rôle à jouer dans l'éducation des familles à ce propos.

Les manuels de sciences sont impersonnels. C'est dans ces manuels que nous pouvons assaisonner nos approches d'un peu de féminisme, comme dans l'exemple d'une mère qui utilise un four 2 KW pendant 3 heures. Combien d'unités d'électricité utilise-t-elle et combien cela coûte-t-il? Ou une fille qui fait du patin avec les bras étendus. Qu'arrive-t-il lorsqu'elle baisse les bras?

Une telle approche féministe à l'égard des sciences permettra aux jeunes filles, aux femmes et aux indigènes de relever les défis des sciences modernes et ainsi de mieux vivre.

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DEVELOPING A FEMINIST PERSPECTIVE ON SCIENCE THAT RECOGNISES THE DIVERSITY OF EXPERIENCES OF WOMEN, GIRLS AND INDIGENOUS PEOPLE

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ABSTRACT

Nowadays emphasis is put on providing science education for all. But it is a fact that herein the feminine gender loses out. For instance, not much gender bias is given in the presentation of scientific concepts causing many girls to drop science after the lower secondary level, thus shutting the door to careers in science for themselves. Yet as they participate in the industrial development of their country they need to be scientifically literate.

The Science taught must be made relevant by featuring the immediate needs of girls, women and indigenous people. This could include topics or familiar objects giving an insight into the scientific principles involved with the applications of science. Elements of health education, diseases, safety, household electricity, basic anatomy and physiology will help to lay aside some old established but misguided habits and customs and lead to better living.

Women in developing countries know little about the science that goes on in the kitchen when preparing their food; they ignore the concepts of balanced diet, hygiene and mother care. On the health front, AIDS is posing a serious problem. Women have an important role to play in

educating their families about these matters.

Science textbooks are impersonal. This is where we can bring in some feminism into the approach, like the example with a mother using a 2 KW oven for 3 hours. How many units of electricity are used and what payment is required? Or a girl doing ice-skating with outstretched-arms. What happens when she puts down her arms?

Such a feminist bias on science will enable girls, women and indigenous people to cope with the challenges of modern science and hence lead better lives.

INTRODUCTION

At present, there is a pressing need for the world community, irrespective of gender, to be scientifically and technologically literate so as to keep abreast with the rapid scientific and technological advances that are taking place everywhere be it in the developed or the developing countries. So far, there is a sharp division into masculine and feminine stereotype roles because science has been given a masculine image and consequently the feminine gender has suffered on various scientific and technological domains.

It must be borne in mind that half of the world population consists of females, hence the urgent need to adopt a more feminist approach in science. A "real life" science that would connect with the feminine gender will not only be an innovation but would raise the scientific literacy of girls

and women. It is a well-known fact that there is a poor representation of women and girls in most countries in the world of science and technology.

Masculine image of Science

Science is given a masculine image in that most scientists have been and are still men and at the same time, science books tend to glorify them. Women scientists are given a low-key profile. This seriously deters many girls and women to become interested in science and technology. All the great scientists of the past are men. It is high time that due credit is given to the contribution of women in Science, for example some reference to the work of **Marie Curie** and **Rosalind Franklin** could be included in secondary school science textbooks. In this way the average girls and women can identify themselves with them and sex stereotyping in science will not be so evident.

Effort must be made to reach girls and women by presenting to them a science which is more in context with their immediate environment and their daily experiences. It is assumed that boys do better in technical matters as they have acquired more experience of tinkering activities.

Research in U.K has shown that girls' attitude to science tends to decline sharply after the first three years in secondary school. This trend is also common in many countries. Intervention at the lower secondary stage may help to prevent this decline and encourage more girls to continue with scientific and technological subjects at the

upper secondary school level, thus enhancing their career opportunities and increasing their understanding of scientific concepts.

How to encourage more girls and women to do Science

Research has shown that girls and women are attracted by animals and plants and everyday objects as well as applied science. By making careful choices of topics and examples which are appealing to them, certain landmark concepts could be made clear to them. Girls often lack confidence in their own abilities and tend to get worked up when they do not understand certain theoretical and mathematical concepts. Working in a well-ordered disciplined environment help them to be more at ease with practical work.

Women in developing countries who have little knowledge of the science in the home could be taught concepts of nutrition, health, basic anatomy and physiology, household appliances by using examples and objects which are familiar to them. Girls and women in developing countries have so many myths and misconceptions about diseases, menstruation, child care and nutrition. For example, a child afflicted by measles ties it up with religious connotation whereas strict hygiene, vegetarian diet and religious ceremonies are strongly adhered to. If these people had some concepts of disease, how they are caught, what kind of health care is required, proper medication could have been administered to the patient. A menstruating girl or woman has to refrain from many of her daily chores as she is considered

unclean.

Child care in developing coutries is done in a haphazard way making use of primitive practices ignoring the science involved if not being on ignorance of it. There is, in some cases, a tendency to ape the Western woman in bottle feeding whereas the advantages of breast feeding could be pointed out for better child-raising.

Certain topics in the physical sciences could be made more appealing by linking them up with real life such as the human body; for example forces could be taught via muscles, light via the eyes, air pressure via the lungs function in breathing. The relevance of science to ourselves can thus be emphasized in a more striking and realistic way.

Feminism in science could be brought out by taking into account the science involved in the kitchen especially. This is not to say that men is to be excluded from kitchen matters. The example used would be of a mother preparing a balanced meal using a 2 KW oven for 3 hours would give her an idea of the number of units of electricity used and the cost involved. The type of dress worn could also reflect the colours of the spectrum of light. The girl doing ice-skating with outstretched arms can give rise to a lot of scientific discussion on the forces, rotating speed etc if she were to put her arms down.

Conclusion

Adequate science education using a feminist approach will definitely provide more opportunities to girls, women and

indigenous people to increase their awareness and understanding of science in their everyday life. This will help them to develop more confidence in scientific and technological issues and equip them to meet the challenges of modern living as well as participate in decision-making for issues in everyday life.

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TRANSFORMING SOCIETY THROUGH SCIENCE AND TECHNOLOGY: THE CASE OF RURAL WOMEN

D' Eunice A.C. Okeke

En dépit de l'importance évidente des sciences et de la technologie dans la transformation de la société, les femmes et les jeunes filles des pays en voie de développement participent et profitent très peu des fruits de la science et de la technologie. Les femmes des régions rurales sont particulièrement désavantagées. Si nous tenons à transformer la société en assurant l'égalité des sexes, alors le problème des femmes des régions rurales et de l'enseignement des sciences et de la technologie doit être abordé.

Ce document met l'accent sur l'enseignement extra-scolaire des sciences et de la technologie, tel qu'il est fourni par le Better Life for Rural Women Programme (BLPRW) (Nigéria), un programme mis sur pied et mis au point par Maryam Babangida, la première dame du Nigéria. Certains de ses objectifs sont spécifiques aux sciences et à la technologie (par ex., éduquer les femmes sur l'hygiène générale, la planification familiale, les soins aux enfants et accroître l'alphabétisation). Le document considère le BLPRW comme une stratégie pour enseigner les sciences et la technologie aux femmes des régions rurales, en analysant de façon critique les activités pédagogiques fournies, telles que les séminaires, les ateliers, les séances de formation pour l'acquisition d'aptitudes, les expositions, les foires, etc. Ce document parle du succès du programme, en tenant compte des points forts et des faiblesses de l'approche non institutionnelle à l'éducation.

Pendant qu'on déploie des efforts en vue d'améliorer le programme BLPRW, on insiste également sur les contributions éventuelles d'associations telles que la GASAT dans le domaine des sciences et de la technologie.

Le document de recherche est disponible auprès de l'auteure.

TRANSFORMING SOCIETY THROUGH SCIENCE AND TECHNOLOGY: THE CASE OF RURAL WOMEN

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Despite the recognized importance of science and technology as tools for transformation of society, women and girls in developing countries participate minimally and enjoy very little of the benefits of science and technology. Rural areas are particularly disadvantaged. If we expect to transform the society through examining gender issues, then the problem of rural women and science and technology education must be squarely addressed.

This paper focuses on non-formal science and technology education as provided by the Better Life for Rural Women Programme in Nigeria (BLPRW), a programme instituted and championed by Maryam Babangida , Nigeria's First Lady. Some of its objectives are specifically science and technology-based (e.g, "to educate women on simple hygiene, family planning, child care and to increase literacy"). The paper examines the BLPRW as a strategy for providing science and technology education for rural women, by critically analysing the educational activities they provide such as seminars, workshops, training sessions for skill acquisition, exhibitions, fairs, etc. The extent to which the programme is succeeding is discussed, taking into account the strengths and weaknesses of the non-formal approach to education.

As efforts are currently being made to improve on the gains of BLPRW, the contributions that can be made by associations such as GASAT by way of collaborating with Nigeria in science and technology a curriculum development provision of human and material resources, are highlighted.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

ENGINEERING AWARENESS FOR GRADE EIGHT STUDENTS

Lionel W.F. Rudd, Georgette Mitchell

L'Engineering Awareness Program vise à encourager les étudiantes et étudiants de la 8e année à ne pas abandonner les sciences et les mathématiques, plus particulièrement, à encourager les jeunes femmes à s'intéresser au génie. Pour atteindre ces buts, les étudiantes et étudiants de la 8e année sont exposés à divers aspects du génie et aux nombreuses possibilités de carrière que le génie met à leur disposition. Les étudiantes et étudiants, réunis en petits groupes, acquièrent une certaine expérience pratique dans le cadre d'une journée passée dans des laboratoires de génie de l'Université Laurentienne. Ces laboratoires incluent : **génie minier, génie général et métallurgie extractive.**

Les étudiantes et étudiants du palier élémentaire sont guidés au travers de cette journée par des élèves-ingénieures et élèves-ingénieurs sélectionnés, qui font des démonstrations d'applications pratiques auxquelles les étudiantes et étudiants de 8e année peuvent facilement apparenter leur situation personnelle. Ces élèves-ingénieures et élèves-ingénieurs sont d'excellents modèles à imiter. Un important élément du programme est qu'il insiste sur le fait que les femmes peuvent devenir et **deviennent** des ingénieures.

Engineering Awareness for Grade Eight Students

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ABSTRACT

The Engineering Awareness Program strives to encourage all Grade 8 students to continue taking science and math courses in secondary school, with particular emphasis on stimulating the interest of young women in the study of engineering. To achieve these goals, Grade 8 students of both genders are exposed to various aspects of engineering and the many career opportunities that engineering provides. The students, working in small groups, are given practical experience during a day spent in selected engineering labs at Laurentian University. These labs include: mining engineering, general engineering and extractive metallurgy.

The elementary school students are guided through this experience by specially selected engineering students, both male and female, who demonstrate practical applications to which the Grade 8 students can relate. These engineering students provide excellent role models. An important element of the program is to stress that women can and do become engineers.

INTRODUCTION

The School of Engineering at Laurentian University, Sudbury, Ontario offers a fully accredited four year program in Mining Engineering and Extractive Metallurgical Engineering, and the first two years of Civil, Mechanical and Chemical Engineering.

For many years the female student population in the School of Engineering was very small (1 or 2 students out of about 80) and between

1975, the inception of the four year mining engineering and metallurgical engineering programs, and 1981, only one female student graduated. In 1981, in an attempt to rectify this situation, a new brochure promoting the School of Engineering was created using inclusionary language and gender neutral terms. Female students were featured in the pictures in mining and metallurgy situations. These brochures were issued to several high schools around the north country but the number of female students enroling in the School of Engineering did not appreciably increase. It was assumed that although there were no tangible barriers to girls entering the program they did not do so because they were not interested or not prepared. It was also suspected that guidance counsellors, teachers and even parents were directing the boys into male type careers and girls into female type careers despite the brochures. This situation was further compounded by the lack of female role models in many of the major professions including engineering.

AWARENESS PROGRAM

During the late '80s it was realized that "something had to be done" to increase the enrolment of young women in the engineering program. An effort was made to target female students with the full impetus beginning on December 6, 1989 - the day of the Montreal Massacre. Using information and ideas from Britain and other centres, a pilot project was put into place at the School of Engineering in the Spring of 1990. It was decided to focus on grade 8 elementary school students for the following reasons.

1) That group is still at a formative age.
2) Grade 8 students are not " streamed". The intent was to redirect interest, especially of the female students, into the sciences, prior to the students entering high school.

3) There is a need to sensitize boys to the fact that women do, and can, aspire to engineering and the sciences.

4) By working with grade 8 students there would be the quickest "pay back", that is, results of the program would be more rapidly evident.

It was decided to start a pilot project over a 3 day period and to involve grade 8 students from English, French Immersion and French schools. Although the School of Engineering offers courses solely in English it was felt that every effort must be made to ensure that the French speaking students had the opportunity to use and practise their language in a scientific setting. To this end we were able to offer three of the eight labs in French.

ENGINEERING LABS (LABORATORIES)

Eight labs was the optimum number selected to give a broad cross section of the material covered at Laurentian, in the time available. The labs selected reflected the Northern Ontario resource base. These labs were as follows:

MINING ENGINEERING

Ventilation:

Purpose: To control unwanted and dangerous gases in mines and surface plants.

Lab: Measurement of the air velocity and the static pressure created in a wind tunnel. The results are plotted on a graph, air velocity versus static pressure.

Rock Mechanics:

Purpose: To understand the properties of rock and the forces that may

be present in rock masses where mining and tunnelling take place.

Lab: Measure the end surface area of rock core samples. Compress these specimens in a universal testing machine (press) to failure (observe the rock burst). Record the force required and calculate the force per unit area. Compare such force to the weight of a car, etc.

EXTRACTIVE METALLURGY

Mineral Extraction:

Purpose: Using different means separate and concentrate the valuable fractions of the ore.

Lab: Use of chemical separation (froth flotation) of minerals and magnetic separation from powdered ore. Observation of liberation factors and ratios (ore to waste).

Pyrometallurgy:

Purpose: Manufacture of metals and alloys using heat (smelting).

Lab: From basic ingredients measure and weigh correct amounts to make brass (or another alloy). Observe temperature and other factors.

GENERAL ENGINEERING

Surveying:

Purpose: Buildings and structures must be properly placed and aligned. Mine workings must be recorded accurately.

Lab: Using surveying instruments measure angles and distances in a three sided traverse (triangle) and using basic trigonometric functions calculate the unknown portions. (Use of Pythagoras' theorem).

Fluid Mechanics

Purpose: A knowledge of how fluids respond and how they influence objects is a vital tool in the design of spaceships, mines and buildings.

Lab: Observe Archimedes' principle, buoyancy, displacement etc. Measure and calculate reactions using simplified arithmetical concepts.

Computer Aided Design:

Purpose: Computers are vital to an engineer in designing, planning, and solving mathematical problems.

Lab: Create a simple drawing using the 'Silver Screen' program.

The material covered in the labs was to be conceptual and include material at or near the grade 8 level. In the surveying lab, students were not taught trigonometry but ratios. In mine ventilation, they learned how to measure air velocity and pressure and create graphs to establish relationships between pressure and air volume. In pyrometallurgy, they discovered the ratio(s) of metals that make the alloy bronze; they saw it smelted, made moulds and watched the bronze being cast into medallions.

It was decided to keep the number of students in each group to a minimum to permit everyone to use the equipment and to interact in every way. With a lab group size of 7 or 8 we could accommodate 2 grade 8 classes (or between 60-70 students) per day.

In order to ensure that the girls were given the utmost opportunity to fully interact with the equipment and become involved, boys and girls worked in separate groups. It has been noted that in mixed group situations, girls tend to be relegated to note taking while the boys get involved with the machinery. It is also known that girls have a tendency to work more co-operatively in problem solving while the boys are inclined to be more competitive.

PROGRAM EVALUATION

The program was evaluated by the Grade 8 students and teachers using a standardized form. Responses from educators and students indicated that the program offered a valuable educational experience. Many teachers expressed a need for such a program. For elementary school teachers who lack the background to teach science and mathematics with a high degree of confidence, a day spent in the engineering labs enabled them to gain vital insight into practical applications of scientific principles. Most students thought the sessions and topics were "great". Many student comments indicated that the activities in the labs can make classroom learning relevant.

STUDENT COMMENTS

- "The lab showed me that the math I am learning is useful".
- "Science can be fun."
- "There are many women studying engineering."
- "You could see how it would be useful in real life."
- "There are many exciting jobs for me in the future."

ROLE MODELS

Role models are essential in trying to interest girls in non-traditional activities. To emphasize the presence of women in engineering, female engineering students were utilized as instructors. These instructors provided role models for the girls as well as for the boys. It is critical to educate young males that girls can and should aspire to become engineers (or whatever) thus breaking the stereotypical views that persist in society.

Such role models are important for adolescents who have to make decisions about courses at secondary school. In their evaluations, the Grade 8 students were impressed by the Laurentian engineering students, their knowledge, and their ability to explain difficult topics in terms that they could

understand. The engineering students gave excellent practical applications to which the Grade 8 students could relate. Some students wrote that now they understood the reasons for studying certain topics. The engineering students were excellent role models, showing that there are many opportunities for engineers and that many women do in fact study engineering.

PROGRAM SUPPORT

The Engineering Awareness Program is an "outreach" program that tries to go beyond the Grade 8 students to "reach" the teachers and parents and to make them aware of the support and resources that are available at Laurentian University. By spending time in the School of Engineering classrooms and laboratories and with the staff and faculty, teachers are able to make their classroom teaching more relevant.

In 1991 funding was obtained through the Ministry of Northern Development and Mines, the Association of Professional Engineers of Ontario, the Canadian Institute of Mining and Metallurgy and the Mining Research Directorate. It was decided to run the project for one week and include about 400 grade 8 students.

In 1992 funding was obtained to include 100% of the grade 8 students from the Sudbury Board of Education, a total of about 1200 students plus 70 students from the Espanola Board of Education. This meant that the project had to be run over a 3 week period. Should the funding continue over a 5 year period, over 6,000 students representing 100% of all the students in the Sudbury Board of Education secondary schools would have been exposed to the Engineering Awareness Program. That means, 100% of the girls, about 3500 young women, would be exposed to the program, the role models, the fun and fascination of science. Hopefully this will open doors, break down

barriers and draw some of our best young minds to exciting and creative careers.

With funding promised for 1993, it is intended to include not only all the grade 8 students from the Sudbury Board of Education but also all those from the Espanola Board of Education plus about 100 native grade 8 students from the North Shore Tribal Council jurisdiction. We are encouraged that the elders of the North Shore First Nations have shown so much interest and requested our assistance.

SUMMARY

Grade 8 students attending the Engineering Awareness Program receive hands on experience in the engineering labs. They have the opportunity to use computers and high tech equipment such as an electronic theodolite (a surveying instrument). They all receive a diploma and a bronze medallion that they have helped to make. They are instructed by dynamic young engineering students (male and female) who are first rate teachers and role models. Professional guidance and help is given by the Sudbury Board of Education. The success of the project is due in part to the commitment of Mr. Jim Smith the Director of the Sudbury Board of Education, the school superintendents, principals, teachers and staff. Appreciation must also be extended to the staff and faculty of the Laurentian University School of Engineering for their technical advice and co-operation for this program. Recognition must also be given to Dr. Irvine Reilly, P. Eng., former director of the school of engineering and Dr. Anis Farah, P. Eng., current director, for their support and commitment to the project.

By spending a day at a university the grade 8 students are offered a "taste" of university life. They are made to feel welcome and at home. University is a less intimidating place for them and it is hoped that they will be

encouraged to return during their high school years to use the library and to ask for help with science and engineering projects.

TESTIMONIAL

This paper is dedicated to the fine young men and women who are students in the Laurentian University School of Engineering and who made this project such a great success. They demonstrated skill and finesse and helped portray the important role of engineering in a highly professional manner. They are to be congratulated.

MEASURING PROGRESS FOR WOMEN IN ENGINEERING, SCIENCE AND TECHNOLOGY - Applying Benchmarking to Human Resources

Jeanne Inch, Carol Paschal, Lyne Leclerc

Un grand nombre de recommandations ont été faites sur la façon dont l'industrie peut rehausser le statut des femmes dans les milieux de travail, et plus particulièrement dans les lieux de travail scientifiques et technologiques qui, de façon traditionnelle, sont dominés par les hommes. De nombreux rapports ont exigé que l'on mesure, contrôle et fasse état des progrès réalisés. Ce dont nous avons besoin aujourd'hui, c'est d'un mécanisme ou outil que l'industrie pourrait utiliser pour déterminer si elle réalise des progrès en matière de recrutement, de rétention et d'avancement professionnel des travailleuses scientifiques, des ingénieures, des techniciennes et des femmes technologues.

L'évaluation des performances est un processus continu visant à mesurer les produits, services et pratiques par rapport à la concurrence ou aux compagnies considérées comme des leaders au sein de l'industrie. Elle pourrait servir d'outil pour améliorer les méthodes de gestion des ressources humaines. Ce document présente une méthodologie pour développer un système d'évaluation des performances, que l'on pourrait utiliser pour évaluer le recrutement, la rétention et l'avancement professionnel des femmes dans les carrières scientifiques et techniques.

Contributions - GASAT 7 International Conference, Canada, 1993
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MEASURING PROGRESS FOR WOMEN IN ENGINEERING, SCIENCE AND TECHNOLOGY - Applying Benchmarking to Human Resources

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ABSTRACT

Many recommendations have been made on how industry can enhance the status of women in the workplace, particularly scientific and technological workplaces that traditionally have been dominated by men. Numerous reports have called for measuring, monitoring and reporting on progress. What is now needed is a mechanism or tool that industry can use to determine whether it is making any progress in the recruitment, retention and career advancement of women scientists, engineers, technicians and technologists.

Benchmarking is a continuous process of measuring products, services, and practices against competitors or those companies recognized as industry leaders, and could be used as a tool to improve human resource management processes. This paper presents a methodology for developing a benchmarking process that can be used to measure the recruitment, retention and career advancement of women in scientific and technical careers.

INTRODUCTION

"Corporations cannot manage attitudes, but they can manage behaviour with accountability, rewards and punishment, as in all other important areas of concern. What gets measured in business gets done, what is not measured is ignored."

Edward W. Jones, Jr., *Harvard Business Review*
quoted in *Breaking the Glass Ceiling*, 1987

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

The emergence of a global and knowledge-based economy demands that Canada be competitive internationally and develop knowledge-intensive industries. Such challenges can only be met if Canada's workforce is well-educated, particularly in the fields of science, engineering and technology.

While Canada's need for highly qualified personnel increases, the number of young people entering Canada's labour force continues to decline. Over the next decade women, immigrants, disabled people, natives and visible minorities will constitute 80% of new workforce entrants. Women make up over 50% of the population, yet their representation in certain fields, especially in engineering, science and technology, is very low. Women make up only 7.5% of those employed in engineering occupations, 18.9% in physical sciences, 27.7% in life sciences, and 32% in mathematics, statistics and systems analysis (Census of Canada, 1986 projected to 1991). Women made up only 3.3% of the certified technicians and technologists in Canada in 1990 (Canadian Council of Technicians and Technologists). In addition, women are not well represented in senior management in Canadian industry; in 1992, they represented only 25.4% of managers in Canadian companies (*Report on Business Magazine*, June 1992). Increasingly women are graduating from universities and colleges with degrees or diplomas in scientific and technical areas (Industry, Science and Technology

Canada, *Women in Science and Engineering: Vol. I and Vol. II*). It is imperative that their expertise be fully utilized. Systemic and attitudinal barriers may lead to under-employment, hinder career advancement, and even cause women to drop out of scientific and technical careers. These attitudes also hinder the adoption of policies and practices that prohibit discrimination and harassment in the workplace and would place women on an "even playing field" with their male counterparts.

This project is part of a comprehensive effort to monitor and report on the implementation of the recommendations of the Canadian Committee on Women in Engineering (April 1992), and the report on Women in Trades, Technology, Science and Engineering produced by the Human Resource Committee of the Prime Minister's National Advisory Board on Science and Technology (March 1993). These reports outline the steps industry must take to improve the working environments for women in these fields, and call for measuring, monitoring and reporting on progress. However, they do not suggest specific methodologies for carrying out this task. After wide consultation with representatives of several industries and industry associations, it became clear that what is now needed is a mechanism or tool that industry can use to establish a benchmark for the recruitment, retention and career advancement of women in these fields, and then

to determine what it can do to build on progress (or success) to date. This benchmark would provide the basis for future assessments and could be used for comparisons across companies within the same industrial sector.

Benchmarking as a concept and a process has relevance for measuring and monitoring progress. It has been defined as "a continuous process of measuring products, services, and practices against competitors or those companies recognized as industry leaders" (Robert Camp, *Benchmarking*, 1989). The concept can be adopted as a tool to improve human resource management processes within specific industrial sectors and even on a cross-sectoral basis. A neutral third party collects selected data from a selected number of firms, compiles it and then distributes it back to participating firms whose confidentiality is protected. Gaps are identified, future performance goals are set, and action plans are implemented to monitor progress.

The first phase of this project was the development of benchmarking options, that is objective and practical methods to measure and report on progress in the recruitment, retention and career advancement of women scientists, engineers, technicians and technologists. In the second phase, a benchmark study will be implemented and tested in, it is hoped, at least one industry sector of strategic

importance to Canada's competitiveness.

Phase I involved the development of a number of options, including costs and action plans, for measuring progress through a benchmark study, as well as the preparation of an annotated bibliography and a list of recent initiatives undertaken by employers to address issues faced by women in the workplace. The project began with the identification and analysis of existing relevant sources of quantitative and qualitative information on the status of women in engineering, science and technology in the workplace. These sources included: databases and research on employment status, responsibility levels, salaries and promotion rates of women and men in these scientific and technical fields; private and public sector policies, procedures and programs affecting the recruitment, retention and career advancement of women in these occupations in Canada; and research on attitudinal barriers to women's full participation in the workforce. Sources reviewed or consulted included: federal and provincial government departments responsible for employment equity and the status of women; employee organizations such as professional associations and unions; industry and employer associations; organizations for women in science, engineering and technology; and independent policy and research institutions.

Gaps in the knowledge base were identified and ways to use existing information and data to measure progress in the workplace were examined. The validity, reliability and cost-effectiveness of the information being considered as indicators of employment status was assessed. Doable and practical methodologies for a benchmark study were developed, with consideration to various options for small, medium and large companies. The views and practical advice of key experts from the private and public sectors were sought, particularly their reaction to the measurement variables and specific methodologies under consideration. These key experts included individuals responsible for managing or administering employment equity programs, human resources specialists, union officials and representatives of the interests of women in engineering, science and technology. The various options were further refined, and the design, action plans and costs of each option developed for the benchmark study.

The purpose of the benchmark study is to examine three areas: stock and flow data on the representation, promotion and retention of women in scientific and technical jobs at all levels, including senior management; existence and enforcement of supportive policies and programs (e.g proactive recruitment programs, unbiased selection processes, women's advisory committees, career development programs, sexual harassment policies, and work and family

policies); and existence of attitudinal and systemic barriers to the full participation of women in scientific and technical occupations in the workplace. The measurements to be considered included: numbers on the representation and distribution of women and men engineers, scientists, technicians, and technologists; hiring, training and workforce adjustment procedures, practices and programs; availability of career development and succession planning programs for women and men; presence of supportive policies, procedures and programs; working conditions; and mechanisms to monitor and report on progress.

In Phase II, a benchmark study will be implemented in at least one industry sector in the 1993-94 fiscal year. The study may be repeated at a later date to measure progress. The focus will be on women in scientific and technical occupations in small, medium and large companies. It is hoped to secure participation of an industry sector that has strategic importance to the future prosperity and competitiveness of Canada. Phase II objectives include: implementation of the action plan to measure the current status of women in scientific and technical occupations in an industry sector; assessment of the effectiveness of the benchmark study; development of options for repeating the benchmark study to measure progress over time; adoption of the benchmarking tool for use in other industrial sectors; and development of a checklist for industry to use internally to

measure the outcomes of their policies, practices and procedures.

Firms today face increasing pressures and many are having to downsize their operations in order to maintain their competitive position. The concept of benchmarking is a positive and proactive process which can be applied to human resource practices and help managers compare the performance of their firms' human resource function with that of other organizations. This benchmarking tool, once developed and tested, can help individual firms and industry sectors develop a clearer understanding of the progress achieved in attracting, developing and retaining women engineers, scientists, technicians and technologists.

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THE INFLUENCE OF WOMEN UPON THE DEFINITION OF A SCIENTIFIC KNOWLEDGE BASE FOR THE PROFESSION OF SOCIAL WORK

Ken Moffatt

Les études menées dans le secteur du travail social offrent un point de vue intéressant sur les influences de la pensée technologique sur le développement épistémologique et éthique d'une profession. L'auteur étudie le monde du travail social au Canada dans les années 1920 et 1930, alors que quelques académiciens comme Carl Dawson tentaient de définir la profession nouvelle de travailleur social comme une matière rigoureuse fondée sur l'empirisme et les faits. Pendant ce temps, des praticiennes comme Charlotte Whitton et Ethel Dodds Parker reconnaissaient l'importance des sciences et de la méthode, mais considéraient également le monde social en terme de pratique. On a découvert que la base de connaissances des leaders féminines a été formée grâce à des valeurs partagées telles que la responsabilité; ces valeurs ont de temps à autre été mises au défi par le point de vue technique. On estime que les femmes ont joué un rôle principal pour s'assurer que la base de connaissances relatives au travail social ne soit pas définie uniquement dans un cadre technique et rationnel ou une compréhension patriarcale du monde social. Une des plus importantes contributions des leaders féminines a été leur lutte visant à maintenir en vie les notions de bonté publique, le but social et les concepts qui auraient été insignifiants dans un paradigme strictement scientifique.

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THE INFLUENCE OF WOMEN UPON THE DEFINITION OF A SCIENTIFIC KNOWLEDGE BASE FOR THE PROFESSION OF SOCIAL WORK

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ABSTRACT

Research within the field of social work offers an interesting study in the influences of technological thought upon the epistemological and ethical development of a profession. The author considers the field of social work in Canada during the 1920s and 1930s, a time when Canadian social work practitioners were organizing as a modern profession. During this time period there was a desire amongst some male academics, such as Carl Dawson, to define the emerging profession of social work as a rigourous discipline based upon empiricism and fact. At the same time leading female practitioners, such as Charlotte Whitton and Ethel Dodds Parker, acknowledged the importance of science and method but also understood the social world in terms of practice. There is evidence that the knowledge base of the female leaders was informed by shared values such as caring and shared responsibility; at times these values were in tension with the technical point of view. It is argued that women have had a leading role in making sure that the social work knowledge base did not become defined solely within technical, rational framework or a patriarchal understanding of the social world. One of the most important contributions of the female leaders was their struggle to keep alive notions of public good, social purpose, concepts which would have been meaningless within a strict scientistic paradigm.

INTRODUCTION

The social work profession in English Canada offers an interesting focus for a study of the influences of technology since it is a profession clearly focused on human well-being with a knowledge base that has been defined in technical-rational terms. Altruism and technique are at the heart of the definition of the social work profession and its knowledge base.

Franklin (1990) offers a useful differentiation of types of technology; it would seem that both types of technology can be traced within the field of social work. Technology,

according to Franklin is not simply hardware or machinery or models of thinking it is practice. There are two types of technology in this case, prescriptive and holistic technologies.

Prescriptive technology involves specialization by process. Labour is distributed within the work process according to specialized tasks and doing is broken down to identifiable steps. Each step within the process is completed by a worker so that the worker has no control over the total creative process. The knowledge base for prescriptive technology is necessarily reductionist and specialized. Prescriptive technologies are preeminent in the modern technological world; there is a tendency to design systems and human matters according to prescriptive technologies.

Holistic technologies on the other hand entail specialized work which is defined by the product. The process is controlled by the doer. Prescriptive technology no longer simply applies to the production of material goods since technology is not simply the application of scientific knowledge but has also become an agent of ordering.

Tasks within the field of social work which involve caring adjustment from feedback and human well being are best defined by holistic technology but in fact there has been a tendency towards conceptualizing social work knowledge and ordering social work tasks as if social work is a prescriptive technology (Franklin, 1990).

A look at the world views of social work leaders during the 1920s and 1930s illustrates a tension between a prescriptive or reductionist approach to social work and an approach that is enframed by the notion of caring; furthermore the tension seems to be divided by lines of gender. Within the profession of social work there was a differentiation of technical capacity according to gender. Baines (1991) has pointed out that with the professionalization of social work in Canada male practices included management and administration, which are prescriptive in nature, while the technology or practice most associated with women was caring for others, which is holistic in nature.

Unfortunately within the context of an increasingly technological and corporate society

during the 1920s and 1930s the practice of caring would necessarily be undervalued as efficiency and economy, the prime concerns of technique and professional knowledge, were becoming widely accepted cultural norms. At the same time with the males entrenched within the administrative and management functions of social work, the patriarchal structure remained firmly in place (Chambers, 1986). The value of efficiency, a focus on management, the structure of patriarchy, the predominance of technique, the focus on specialized knowledge and the assumption of the moral superiority of the professional created an interplay of social realities which made it increasingly difficult for women to define themselves as full members of the profession as their "technology of caring" stood in tension with other social forces.

IDEOLOGY OF SCIENTISM

Carl Dawson was actively involved in the creation of the Canadian Association of Social Workers during the 1920s. Dawson, a sociologist at McGill University in Montreal, had been trained at the Chicago School of Sociology where the primacy of research was emphasized in terms of understanding social institutions and social conditions. Carl Dawson clearly accepted science and technology as a necessity of the modern age. He never tired of promoting sociology and social work as scientific disciplines (Shore, 1987; Dawson, 1927). In the early 1920s Dawson was amongst those who emphasized research over action as the solution to social problems. He felt that social research and science would provide insight into social issues which would then create the possibility of a better society. Reform was considered to be ineffective by Dawson since it was not efficient and it lacked the control and direction towards standards and ideals which scientific understanding allowed for (Dawson, 1927).

Dawson (1923) described social sciences as an undeveloped physical science that was 300 years behind in development. Since social problems tended to be beyond the limits of the state of social work knowledge and technique he called for social research as a way of defining intelligent social action. Change should be based upon facts about social life and

scientific tools to "get at yet more fundamental facts" (93). Dawson suggested that too much of social work intervention had been based on values, what ought to be done, and legislating what must be rather than ascertaining what actually existed and what was possible. Dawson separates the world into dichotomies such as the subjective versus the objective; the emotional versus the disinterested; he has a technological liberal bias towards control and objective intervention. He supported a scientific approach which was reductionist in nature (Hutchinson, 1986) and seemed to have the confidence in the future of a professionally and technically defined society.

Carl Dawson approached research from the point of view of the detached value-free perspective of a social scientist. Moral concerns, ethnic loyalties, and religious beliefs were considered to be irrelevant concerns of the private individual in his studies of social groupings. Social scientific knowledge not only increased understanding of social problems but it also had the effect of undermining the values of reformers who challenged the dominant assumptions about technological development. He took a deterministic environmental approach to understanding human behaviour while avoiding the assumptions that the dominant group made about racial superiority and technological progress. Dawson divested values of emotion explaining that they could be calculable and mundane. He assumed that the values of the dominant sector of society were the result of detached scientific reflection (Hutchinson, 1986).

One might argue that Dawson's confidence in the possibilities of fact and science was an ideology. Ideology focuses on what ought to be done or valued, it is a normative future-oriented stance. While science is diagnostic in nature or critical , ideology is apologetic concerned with defending patterns of value and belief (Hutchinson, 1986). Dawson's argument for a scientific approach to social work takes on an apologetic future-oriented tone. His perception of the ideal is for a community where efficient institutions create joy, contentment and vigourous service. He wishes for so complete a scientific understanding of life based upon fact that life could be controlled and directed so that reform and cure are

unnecessary (Dawson, 1923).

PRACTICE BASED UPON SYSTEMS OF SHARED SIGNIFICANCE

Charlotte Whitton was one of the founding mothers of modern professional social work. While in her positions with the Social Service Council in Toronto from 1918 to 1922 and the Canadian Council of Child Welfare from 1925 to 1941 she worked ardently to increase the profile, professionalism and the legitimacy of social workers. Ethel Dodds Parker, an active social worker within the settlement house movement (Parker, 1975) and the director of Toronto's Public Welfare Department, was one of the few female social workers along with Charlotte Whitton to reach a position of authority during the 1920s. (Rooke and Schnell, 1987; Baines, 1988).

Both Charlotte Whitton and Ethel Dodds Parker would agree with Dawson with respect to the need to develop a scientific and rational approach for social work while promoting increased credentialism and professionalization of the field. At the same time social work for Whitton and Dodds Parker was a vocation linked to religious belief; the faith perspective was not perceived to be in contradiction with the move to a more scientific, professional approach to the field (Rooke and Schnell, 1981, Parker 1975, Parker 1926).

Ethel Dodds Parker was not interested in simply promoting a technical professional stance to ethics. Rather she was concerned that people understand the religiosity inherent in the practice of social work. While working in the settlement house movement she was concerned that the religious significance of her practice was not to be measured against some notion of evangelical success. Ms. Parker explained that workers within the settlement houses felt that social work was an outlet for deeply held religious motives. The activity of social welfare was implicitly religious in nature and was expressed through the practice of love, approval, warmth and admiration. Religious conversion was not an appropriate measure of success within the settlement houses since social work practice itself had an inherent religious significance (Parker, 1975).

Ethel Dodds Parker and Charlotte Whitton along with Dorothy King defined the purpose of social work in a pledge published in 1936. It reads:

> I pledge myself to the service of those whose responsibility is entrusted to me. I promise to place their needs before my own desires. I vow my loyalty to the service in which I am retained and should my honour conflict with this duty, I promise to withdraw from, and as far as in me lies, to bear myself without malice towards it. And I ask my God to give me knowledge of truth, faith in goodness and the power to good in His service (Rooke and Schnell, 1987, 100).

The pledge is interesting in that it represents a shared understanding of social responsibility based upon faith. There has been a tendency in social science to view faith as private and social issues as public. Faith rather than being a private matter can be defined as systems of significance which are socially available. These systems which include beliefs and meaningful objects help to order subjective life and guide behaviour. One must be cautioned against understanding the history of social work solely through events, environment, consequences of reform ideas or the development of a social scientific knowledge base but should also consider the beliefs and values of the social workers; to do this one should consider "faith as a public reality involving participation in socially-available systems of meaning" (Hutchinson, 1986).

The pledge is illustrative of a system of significance shared by these female social workers defined by responsibility and caring. It would seem that the above statement of social work purpose stands outside the prescriptive technological world view as it attempts to deal with goodness, a concern which is meaningless within the language of science (Minogue, 1990). At the same time the ethic of caring as a value central to social work does not necessarily reflect a liberal, technological point of view concerned with mastery and individualism. Caring has been identified as a key element in women's ethical thinking. A male approach tends to seek general rules to resolve conflict while females tend to focus on relationships and seek alternatives whereby no one loses. The ethic of caring focuses upon

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relationships while evaluating moral criteria in terms of responsibility to the other (Sherwin, 1989).

The systems of significance suggest the necessity of developing a knowledge base which is more holistic in nature. Certainly the type of social science that Carl Dawson suggests does not define a way of knowing which captures the intent of practice and the ideals of service as defined by the female practitioners. Perhaps for the women the development of social work knowledge was a more complicated affair. The female practitioners were struggling with a subtle and complicated way of knowing in which they tried to balance a confidence in the technological development with a continuing belief in a spiritual element to helping.

CONCLUSION

It may be argued that social work as a profession is particularly susceptible to broader social values such as the liberal value of personal freedom, the technological value of efficiency and is likely thefefore to be organized as a prescriptive technology. On the other hand the lack of consensus with respect to the knowledge base, the purpose and the ethical stance of social work that is evident in the foregoing paper suggests that social workers retained a sense of the holistic approach to helping and caring for others.

It might be argued that practice based in faith has helped to develop a type of knowledge within the field of social work in English Canada that has not yet been fully understood. The fact that social work is not a functional science need not be viewed as a weakness but rather can be viewed as a strength as social workers, particularly female social workers, draw their influences at times from without the public paradigm of the dominant group which is based upon patriarchal understanding of the world.

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TOWARDS GENDER-FAIR ASSESSMENT IN SCIENCE I: THE PROCESS OF THE RESEARCH

Lesley H. Parker and Léonie J. Rennie

Ce document est le premier de deux documents sur les progrès réalisés dans le cadre d'un important projet sur l'égalité des sexes financé par l'Australian Commonwealth Government. Dans ce document, on met l'accent sur le processus de recherche et sur l'ordre du jour des réformes épistémologiques, politiques, sociologiques et pédagogiques affectant la recherche. Ce document décrit le climat dans lequel se fait la recherche, compte tenu des priorités nationales établies. À un niveau plus personnel, il décrit et analyse les réactions d'enseignantes et enseignants et d'autres personnes à l'égard de la recherche et les interactions entre ces personnes et les chercheuses et chercheurs, mettant ainsi en lumière les procédés de déconstruction et de reconstruction des perspectives de certains participants. Le document intéressera toutes celles et tous ceux qui font de la recherche ou envisagent d'en faire sur la condition féminine.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

TOWARDS GENDER-FAIR ASSESSMENT IN SCIENCE I : THE PROCESS OF THE RESEARCH

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ABSTRACT

This paper is the first of a pair which report progress on a major project on gender-fair assessment funded by the Australian Commonwealth Government. In this paper the focus is on the process of the research and the concern is with the epistemological, political, sociological and educational reform agendas which impact on the research. The paper describes the climate within which the research is being conducted, with reference to the declared national priorities. At a more personal level, it describes and analyses the reactions to the research by teachers and others involved and the interactions between these people and the researchers, highlighting the processes of deconstruction and reconstruction of some participants' perspectives. The paper will be of interest to all who either carry out or intend to undertake feminist research.

INTRODUCTION AND BACKGROUND

A significant contribution of feminists to social and educational research has been to draw attention to the importance of the process of research (as distinct from the product, which typically is the focus of mainstream journal articles). Roberts (1981, p.1) for example noted that "the problems raised in personal accounts of research are themselves of sociological importance, and that such accounts can give...a lively insight into research often denied by conventional methodology textbooks..." This recognition of the importance of process is also implicit in Sandra Harding's view that feminist inquiry "insists that the inquirer be placed on the same overt plane as the overt subject matter" (1987, p.9) and that it makes explicit any differences in interpretation between the inquirers and other participants in the research.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

In the case of the research described here, the differences in perspective between ourselves and the other participants have led to a number of changes and compromises. Perhaps, like the women responding to Belenky, Clinchy, Godberger & Tarule (1986), we have learned to soften certain ideals that have proved to be unworkable.

For some considerable time we have shared a strong interest in assessment. In Lesley's case, this interest was one of the driving forces behind a decision in 1985 to take up a position with Western Australia's Statewide assessment and certification body, the Secondary Education Authority. At the time she had become acutely aware of some of the research findings concerning gender bias in multiple choice tests, and was particularly intrigued by the lack of attention at official levels to these findings (some of which had lain dormant in the literature for more than a decade). In Léonie's case the interest was focused on the extremely limited nature of assessment practices in physics, which had led almost exclusively to problems of little relevance to everyday life, problems in which, essentially, students plugged numbers into formulae in a fairly mindless fashion.

In 1990 we applied to the Australian Research Council (the major organization supporting educational research in Australia) for a grant to conduct a project on gender-fair assessment in science and mathematics. In a fiercely competitive situation, in which less than a third of proposed projects are funded, and more than three quarters of funded projects have a male as the Chief Investigator (McGaw, Boud, Poole, Warry & McKenzie, 1991) our proposal was rejected. The one Assessor's report which was completed (out of the three requested) was less than enthusiastic, especially about the extent to which the project would contribute to the development and advancement of theory.

By the following year the national climate with respect to education and educational research had undergone considerable change. National goals for schooling had been developed and disseminated, and, in the context of

these, eight areas of learning (of which science was one), and four "bands" defining student achievement-related progress had been defined for the school curriculum. For each area of learning, procedures had been set in train to develop a *National Statement* (defining the nature and scope of learning, and summarizing the intended outcomes of schooling) and a *Profile* (providing a common language for reporting on student achievement).

In addition, a number of national committees had been set up, the accumulated outcome of which was a set of recommendations for seven key employment related competencies (Australian Education Council, 1991), together with principles to provide for nationally consistent assessment and reporting (Mayer, 1992). While initially the brief of these committees pertained to education and training in grades 11 and 12, increasingly their recommendations were permeating throughout the whole of schooling. The importance of assessment in this context was not lost on either policy makers or practitioners, and the potential for national testing and assessment was recognized by many – some with approval, some with dismay. Further, because of the explicit commitment of the Commonwealth Government to social justice, especially in relation to increasing the participation of women in science and engineering, some people were particularly concerned to ensure that issues of gender equity were addressed adequately in the new developments.

In this changed national climate we revised and resubmitted our 1990 proposal. In so doing we consulted as much as possible with others who had been successful in obtaining ARC grants, and we did a little lobbying to draw attention to gender-fair assessment as a high priority research area, with reference to international research such as that by Kulm and Malcom (1991). Our proposed research was declared by its three 1991 assessors to be "important", "timely" and "fundamentally important". It was funded quite generously (by Australian standards) for two years. This paper describes

some of our experiences during 1992, the first year of implementation of the project.

OVERVIEW OF THE PROJECT

The aims of the project are

(i) to review critically the research evidence about the presence, nature, identification and explanation of gender bias in assessment procedures, especially in science;

(ii) to determine the degree to which major methods of assessment in 12th grade physics in Western Australia appear to function differently for males and females, and to develop a hypothesis to explain any differences;

(iii) to test the hypotheses developed in (ii) by means of analysis of teachers' and students' responses to a range of assessment items in physics;

(iv) to generate a theoretical framework with widespread explanatory and predictive power;

(v) to document and disseminate alternative gender-fair assessment practices which could be adapted to a wide range of assessment tasks;

(vi) to produce and disseminate a set of guidelines applicable to gender equitable assessment tasks at both State-wide and school-based levels.

Apart from the literature review, the methodology of the project involves detailed analysis of the content and outcomes of 12th grade examination papers and school-based assessment tasks, work with teachers on alternative methods of assessment, and work with students to monitor their cognitive and affective responses to different types of assessment tasks. To date, our empirical research in relation to aim (iii) above has focused on working collaboratively with physics teachers to develop their skills and confidence in relation to gender-fair assessment.

We recognized at the outset that, for some teachers, participation in our project was likely to involve a significant reconstruction of their current perspectives on physics, on assessment, on the kinds of knowledge and

skills required to achieve well in physics, and on the kinds of students who might be expected to achieve well in physics. We were not wrong! The following small sequence from our interaction with teachers demonstrates the extent to which such reconstruction may be necessary.

RECONSTRUCTING TEACHERS' PERSPECTIVES

To appreciate this sequence fully, it is important to understand that the 12th grade physics curriculum in Western Australia has for many years remained strongly in the tradition of a "received " curriculum, with an emphasis on, for example, routine numerical exercises, contexts which are unfamiliar to students and disembodied theory. Recent revisions to the curriculum (reflecting, at least in their rhetoric, some of the philosophies espoused by GASAT) are about to be implemented. They involve a humanization of physics, with an increased emphasis on relevance to students' everyday experiences and interests, on language and communicaton, on qualitative explanation, on practical applications, and on science/ technology/ society issues.

It is also important to understand that of the 12th grade physics teachers in Western Australia the vast majority (over 90 percent) are male, and further, that despite our best efforts, the groups of teachers with whom we have dealt to date reflect these proportions of males and females. The problem is further compounded by the fact that many of the current group of physics teachers have themselves been educated in the tradition of the "received" physics curriculum described above. Only a few, who have been closely involved with the recent revisions to the curriculum have any commitment to a "humanized" physics, or to the achievement of anything other than a male elite in physics. Thus we learned very quickly that an important first step in the reconstruction of our physics teachers' perspectives was to present them with some evidence of female achievement in the subject.

The evidence we used comes from some ongoing research based on the general principle that sex differences in performance vary with different assessment tasks (Parker, 1992). The teachers were given a brief overview of research suggesting that males appear to have an advantage on multiple choice tests (particularly in association with external assessment), while females appear to have an advantage on assessment tasks where a more extended response is required (particularly in association with school-based assessment). (See, for example, Bolger & Kellaghan, 1990; Harding, 1979; Mazzeo, Schmidt & Bleistein, 1989; R. Murphy, 1982; Victorian Curriculum and Assessment Board, 1988, 1989; Wood, 1978). The teachers were then walked through evidence demonstrating the extent to which such a pattern is evident in 12th grade science subjects in Western Australia .

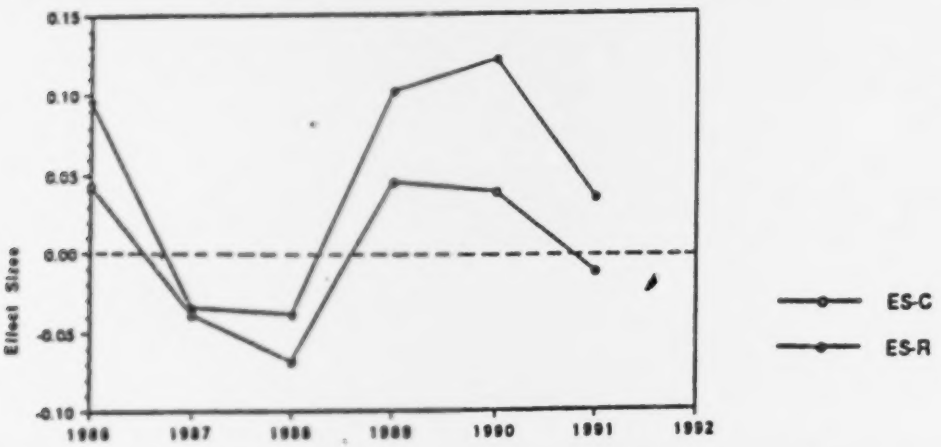

Figure 1. 12th Grade Physics, Western Australia, 1986-91: Gender Effect Sizes for External Examination Scores (ES-R) and Scores with School-based Component (ES-C)

The evidence is drawn fom the official State-wide data base for each of the six years between 1986 and 1991. The analysis is presented as a set of Effect Sizes (see Figure 1). These Effect Sizes demonstrate the differences in physics performance between males and females both on external examination scores (labelled ES-R in Figure 1) and on scores which include a large component of school-based continuous assessment (labelled ES-C in

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Figure 1). Conventionally, an Effect Size of 0.2 is taken as being of practical significance, and a negative Effect Size represents an outcome in females' favour. (We abhor the association of femaleness with negativity, but the Effect Size statisitic is so useful that we continue to use it.)

The teachers' attention was drawn to three points demonstrated by Figure 1. First, none of the Effect Sizes in physics reached a level of practical significance. Second, in two of the six years, females performed better than males on both the external examination and the school-based assessment in physics. .And third, without exception, the Effect Sizes for scores with a school-based component were more towards the negative (i.e. more in females' favour) than those for external examination scores.

As a group, our physics teachers regarded all three of these findings as problematic. The first one did not confirm their perception that males achieve considerably better than females in physics, while in relation to the second one they were quite openly skeptical. They immediately questioned the data. Was it really the whole Statewide population of physics students, or did we select a sample? How is the Effect Size actually calculated and how "good" is it as an indicator of differences between groups? We tried to deal patiently and courteously with such questions, although this was not always easy, especially given the implication that we might have selected a sample to confirm our personal beliefs about gender differences in achievement in physics. When reassured (to a degree) on these kinds of points, the teachers then shifted to inspection of the graphs, suggesting, for example, that in the year when the Effect Size on examination scores was most positive the examination paper was particularly challenging. In other words, when the going gets tough, the boys really get a chance to shine!

It was the third finding, however, which generated some of the most interesting discussion. Generally, while the teachers could accept that school-based assessment favours girls, they tried to explain this finding away

with anecdotes about teachers being more lenient when marking girls' work. It was suggested, for example that teachers give girls higher marks than boys because they like the girls or because the girls' work is neat or because the girls have worked so quietly and conscientiously. Although we challenged these kinds of assertions with findings such as those of Spear (1984), showing quite the opposite gender effect (for example that teacher marks for a piece of work are higher if they think it is "John's work" rather than "Jane's work"), such challenges appeared to have little impact. Quite apart from this issue, however, perhaps the most disturbing feature of teachers' perceptions was their virtually unshakable view that externally administered tests are more "objective", and are the "true" measures of student achievement.

IMPLICATIONS

It was clear from all of this that the teachers had a very strong conviction about the kinds of students who might be expected to achieve well in physics, and that those students were male. It was also clear that the processes of deconstruction and reconstruction of teachers' perceptions of physics, of assessment, of achievement, and of the interaction of all three of these with gender, were going to be a lot more time-consuming than we had anticipated. We see this as having important implications for the achievement of our stated aims (v) and (vi). We could of course carry on regardless, making unilateral decisions about gender-fair assessment practices and disseminating, without further consultation, a set of guidelines which we believe to be applicable to gender equitable asessment tasks. We do not see this as being particularly useful, however, given what we now know about physics teachers' typical beliefs.

As we will describe in the next paper, we have chosen a strategy which has two major thrusts. First, we have focused on physics assessment tasks used currently by teachers, with the aim of developing and disseminating

exemplary items. Second, we have adopted a stance, through a contribution to the national science teachers' journal, which focuses more on fair and valid assessment practices and less on gender-inclusivity. To us they are the same thing in any case, and the advantage of this approach is that it seems to make the ideas and concepts more palatable in the first instance. Only time will reveal the extent to which these strategies are successful. Hopefully we will have a positive report to make to GASAT in 1995!

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THE HISTORY OF FEMINIST THEORY AS A BASIS FOR REVIEW OF THE GENDER AND SCIENCE QUESTION

Sharon Parsons

Bien que le nombre de femmes qui choisissent de se lancer dans une carrière scientifique ait augmenté, la majorité d'entre elles optent encore pour des carrières dans les secteurs de la santé ou de la biologie. Les femmes continuent d'être sous-représentées dans le secteur des sciences physiques (Kahle, 1985). C'est pourquoi la plupart des études en enseignement des sciences traitant de cette question mettent l'accent sur la raison pour laquelle les femmes sont moins «douées» et sous-représentées dans le secteur des sciences. De telles études tentent habituellement de démontrer une certaine déficience chez les femmes ou dans leur environnement, ou les deux. Bien que les résultats de telles études aient souvent donné naissance à des projets d'intervention, il serait peut-être préférable d'envisager la possibilité que c'est l'enseignement des sciences qui est déficient. Le point de vue constructiviste de la connaissance fournit la base d'un tel argument. Plus particulièrement, il pourrait être utile d'élaborer une sous-section de la position constructiviste, la construction sociale de la connaissance. Une autre perspective théorique, qui serait utile pour considérer les sciences en tant que construction sociale serait la théorie féministe. Plus spécifiquement, l'histoire de la théorie féministe fournit une base pour examiner les efforts déployés pour les sexes et les sciences. Je tente, par le biais d'une étude de cas autobiographique, de vous expliquer pourquoi mes études visent principalement à tenter de corriger une déficience perçue plutôt qu'à mettre au défi la question plus vaste de la nature de l'enseignement des sciences. L'histoire de la théorie féministe me sert de cadre analytique pour explorer cette question d'une perspective post-moderniste.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

1068

THE HISTORY OF FEMINIST THEORY AS A BASIS FOR REVIEW OF THE GENDER AND SCIENCE QUESTION

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ABSTRACT

Although the number of females who choose scientific careers has increased, the majority are still opting for the health or biological sciences. Females are still underrepresented in the physical sciences (Kahle, 1985). Most of the research in science education concerned with this issue has therefore focused on explaining why females underachieve and are underrepresented in the sciences. Such research, generally presents a deficiency model which views females or their environment, or both as being deficient. While the results of such research has often formed the basis for intervention projects a more appropriate analytical position might be the viewing of school science itself as being deficient. The constructivist view of knowledge provides a basis for making such an argument. In particular, it might be helpful to draw upon a sub-section of the more general constructivist position, the social construction of knowledge. Another theoretical perspective which is helpful in the viewing of science as a social construction is feminist theory. Specifically, the history of feminist theory provides a basis for examining work in the area of gender and science. Through the use of an autobiographical case study I will attempt to explain why my research has focused on attempting to correct a perceived deficiency rather than challenging the broader issue of the nature of school science. The history of feminist theory will provide an analytical framework for exploring this issue from a post-modernism perspective.

The Viewing of Female Achievement and Participation in Science from a Constructivist Perspective

The epistemological position which has influenced the interpretation of the autobiographical data in my study is constructivism (Magoon, 1977). The constructivist perspective is one which acknowledges that individuals through their own mental activity experience the environment and social interactions through their own interpretive framework. Within the constructivist framework the social construction of scientific knowledge is a particularly useful analytical framework. This position is that knowledge is socially constructed rather than that there is an objective reality to be discovered.

When we examine studies which focus on explaining gender differences in science much of the theory has been written within the boundaries of psychology or sociology and proposes motivational deficiencies in females. Beyond documenting gender differences the outcomes of most research presents

a deficiency model which suggests that females or their environment, or both are deficient in science. This research orientation can be viewed as an illustration of blaming the victim. An alternate analytical position might be the viewing of school science itself as being deficient for females. After all, if school science can cater to male interests and experiences then why can it not cater to female interests and experiences.

Since researchers are engaged in the construction of knowledge then it is fair to assume that gender biased research would produce findings which perpetuate the assumptions and biases of the researchers who produce them. For example, researchers with an androcentric view of science would perpetuate the assumed superiority of men and serve to place the blame with women. Traditionally women have been taught to assume the fault is theirs and they are reticent to look externally for the cause of the problem. I would argue this may even be true for female science educators who are attempting to bring a feminist perspective to science.

Feminist Theory and the Social Construction of Science

The feminist movement is not a unitary movement. Within feminist theory there is a wide range of positions. Feminist theory is characterized by some commitment both to critique and to a project for change (Noddings, 1990). Feminist scholars have always expressed an interest in examining the gender and science question (Tuana, 1989). The history of feminist theory provides a basis for the analysis of research work in science education. In particular I find the categories constructed by Kristeva (1982) to describe feminist history to be useful. She describes feminism as being first, second and third generation. First generation - women seek equality with men, the typical liberal position. Liberal feminism is mainly concerned with unfair employment practices. This a political criticism in favour of equal opportunity for the sexes in science careers; it does not attempt to question the androcentric biases within science or science careers. Second generation - women embrace their own special qualities and reject uncritical assimilation into the male world; the emphasis here is on moving the best female qualities into the public world. Third generation - women critique what they sought and

accomplished in the first two phases and seek solutions that arise out of a careful synthesis of old and new questions. Such a view of feminism, as presented by Kristeva is not only descriptive but one of continuous evolution. Based on such a pattern one would conjecture that feminism will continue to evolve and move beyond a third generation.

Offen (1988) uses another classification of feminist theory. She talks of individual and relational feminism. Individualistic Feminism is often associated with liberal feminism which aims mainly at securing for women rights and privileges equal to those of men. Whereas relational Feminism advocates gender sensitivity and emphasizes experience, needs, and responsibility. In conclusion, one striking difference we note is that unlike Kristeva's historical analysis of feminist theory Offen's classification is primarily descriptive.

Another label which has been used to describe one area of feminist theory is radical feminism. Radical feminism argues that scientific ideologies and philosophies are based on androcentric foundations. These androcentric foundations permeate the social structure of science, its applications and its methodologies. This critique questions the nature of scientific ideology (Keller, 1985). Throughout history, science has prided itself on being an objective body of knowledge pursued by rational and unbiased individuals. The scientific method is based on hypothesizing, testing and retesting to ensure the validity of the results. Through the use of these apparently rigorous rules, the scientist is led to believe the result is objective knowledge. Objectivity in science is supposedly maintained by separating the knower and the knowable. Objectivity in scientific inquiry has strong masculine links and in particular, is linked to a history of seeking dominance and control over nature. Metaphors often portray the scientist as masculine and nature as feminine. What is ignored is the social context in which the method is developed and used.

Post-modern feminists (Nicholson, 1990) pose a significant question about gender and science. They ask who are the women we are talking about? Women are not homogeneous. We differ by such factors as class, race, culture, and sexual orientation. This suggests that multiple feminists voices be heard not a dominant feminist voice (white, Western, academic).

An Autobiographical Case Study

My research assumption is that through an autobiographical case study I can better understand some aspects of the focus of research in the area of females and science. I am particularly interested in an analysis of the factors which may have influenced my research agenda. How did my position relate to the dominant research paradigm in science education with regards to the gender issue? How can I contribute to a feminist critique of science education.

Feminist Methodology: A Way of Becoming Critical

While there has been much talk about feminist methods some feminist question as to whether or not a feminist method exists (Roberts, 1981). Sandra Harding (1987) distinguishes between method, methodology and epistemology. She defines method as techniques for gathering evidence, methodology as the theory and analysis behind the method, and epistemology as theory of knowledge. She claims that the three are related but what is distinctive about feminist research is not the use of feminist methods but the use of feminist methodology and epistemology. It is the latter which I choose to employ. The employment of a feminist methodology carries with it a responsibility for transformative action. One of my aims is to empower myself and others by reflecting upon our research experiences and understand the factors influencing our agenda. A part of what transformative research is about is empowerment by gaining an understanding about the forces acting to shape our lives. Empowerment is viewed as being achieved when the actors are able to change their situation. Rather analyze the works of others the particular form of research to be used is an autobiographical case study. The specific technique employed in the autobiography was one of self-reflection on my own research agenda.

Autobiographical Sketches from my Diary

Some of the sketches which I shall present will be from published works covering a period of 1987 to 1991. These sketches can be interpreted as representative of first, second, and third generations of feminism as described by Kristeva (1982). I will also describe my work using Offen's (1988) categorization of individualistic and relational feminism. In analyzing my

work I have noted that while some of the thoughts and ideas that I communicated at any one time could be described as representing various descriptions of feminism, it is therefore the dominant focus that I have used as the basis for my analysis.

First generation feminism/individualistic feminism. The first sketch that I would like to present is an abstract from my contribution to the Fourth GASAT (Girls and Science and Technology) Conference, 1987.

> One of the factors affecting students' success in science is their existing knowledge prior to instruction. One theoretical position which can be taken is that such knowledge is constructed through prior experience. This study focused on one type of prior experience, namely tinkering. It examined the role of tinkering in students' approaches to the study of electricity. The appearance of tinkering in the science education literature centers around the gender issue of females and science. Specifically research has focused on specific topics within physics such as electricity, where the claim has been made that the greatest gender difference occurs.However, before one can investigate such a claim tinkering needs to be defined within the context of physical science. This study utilized a case study approach which consisted of multiple cases designed to explore tinkering and how it interacts with instruction in one area of physical science; with a focus on how gender gets played out in this context. (p. 97)

The focus here can be described as individualistic feminism or first generation. While my reason for exploring tinkering was primarily to understand how to improve instruction for females in the physical sciences I was directing all my energy to understand an activity which males have typically excelled in. This is an illustration of a kind of thinking that can be described as individualistic or first generation feminism. The main argument presented focused on having females acquire actional knowledge in the physical sciences such that they could equal the males in achievement and participation. Such an argument does not look at broader issues such as, the nature of science but indirectly lays the fault with the females for not having acquired such knowledge.

Second generation feminism/relational feminism. Based on a review of science education literature I noted that most of the discussion of the gender issue had centered around achievement on large scale achievement tests. Given that achievement had received so much attention when I was presented with the opportunity to examine such data I was happy to reanalyze it from a feminist perspective. The result was the appearance of a co-authored article

in the International Journal of Science Education, 1989. My major role in writing that paper was that of providing a theoretical framework to analyze the data. The following abstract summarizes the outcome:

In large-scale testing programmes it has been consistently noted that males tend to out-score females in science and mathematics, particularly in the areas of physical and earth/space sciences. The third provincial assessment of science in Br'tish Columbia, Canada, which tested over 100,000 students in grades 4, 7 and 10 has again shown strong gender-related differences in various domains of science achievement. Explanations for these differences have, in the past, centered on either biological or sociological considerations with explanations concerned with the gender orientation or 'realm of experience' of items receiving a great deal of support in the academic community. It was found, however, that there was considerable disagreement among a panel of judges regarding the gender orientation of many items that calls into question some of the previous work in this area. It is also possible that observed differences in achievement in domains higher than the knowledge level may be an artefact of item construction. Many items in higher level domains are dependent on knowledge that has been shown to have strong gender-related differences. As such, gender-related differences in achievement in domains such as application, critical and rational thinking, technology and the nature of science, and safety may be predetermined through item selection for the instruments. (p. 371)

The abstract illustrated that I moved beyond liberal feminism to question the androcentric knowledge base of standardized achievement tests (Bateson & Parsons, 1989, pp 373-374). Such an argument suggests a movement beyond first generation feminism.

While feminist theory was introduced in the paper to question the knowledge base of standardize tests I still resorted to putting forward differential experience rather than focusing on the nature of scientific knowledge. I avoided the question of examining the nature of science. I relied instead on the mainstream viewpoint presented in the science education literature. Beyond raising the issue as a question I did nothing to advance the argument. In fact later in the paper when we reviewing some of the arguments for gender differences the dominant focus was on using the argument of differential experiences to explain gender differences (pp. 371-373). Extensive efforts were made to explain studies which suggested that differential experiences are important in explaining gender differences in science. While we used the argument for changing test construction we only

paid token attention to the idea of a new knowledge base for science. It was at best be a token effort.

Movement towards third generation feminism. Another illustration of second generation feminism thinking is reflected in a paper which I presented at the Sixth International GASAT Conference, 1991.

I would like to share the findings of a qualitative study of female and male participation in physical science activities. Specifically I will report on a case study of female and male students engaged in a hands-on study of electricity. Based on a qualitative analysis of survey data, interviews, and classroom observations the experiential, social and personal factors influencing female and male participation in physical science activities will be metamorphically described as an apprenticeship. That is, males will be described as engaging in an informal apprenticeship. For a discussion of gender differences in the apprenticeship factors I will draw upon the work of Belenky, Clinchy, Goiberger and Tarule (1986). Their work provides an interpretive framework for the viewing of areas of physical science, such as electricity as "connected knowing" for males and "disconnected knowing" for females. (p. 286)

This was the abstract which appeared in the conference contributions. At the conference I felt the need to critique my contribution which had been written six months earlier. The basis of my critique was that by focusing on activities in physical sciences which males are good at was an illustration of blaming the victim. Why had I not focused on an area of science where females typically excel and use that as a model? Another issue that I raised was why not examine the nature of science itself. This suggests that while I was sensitive to the need to improve science instruction for females I still laid the blame with the victim. This was despite the fact that feminist literature enabled me to described such activities as disconnected knowing. It is only recently that I am ready to entertain the thinking of what has been described as third generation feminism. This position was outlined in my last paper at the National Association of Research in Science Teaching (Parsons, 1992).where I critically examine my past work

Discussion

A brief analysis of my work based on Offen's categories shows me moving from individual feminism to relational feminism quite early. Whereas further

analysis of my work based on Kristeva's categories shows a more gradual progression from first generation feminism to third generation feminism. Kristeva's description of the history of feminist theory was useful in interpreting my research agenda. Not only is the history of feminist theory useful as analytical scheme it helps examine some of the factors influencing my research agenda. Be[illegible]id being influenced by feminist theory I have worked within a science education research community. This community has influenced the direction of my work. It appears that the science education community has had a stronger influence on my work (**theories of action**) than feminist theory (**espoused theories**). It was a classical case of espoused theory being different from theory of action.

Based on the analysis of the factors influencing one researcher to adopt a deficiency model it can be asked if my research paradigm was consistent with the dominant paradigm in the science education community. A review of literature might explain why we are yet to challenge the nature of science itself. While alternate research paradigms for exploring the gender issue do exist in other fields it appears that science education has yet to adopt such paradigms. Feminist scholarship appears to have had limited influence. While I attempted to bring a feminist agenda to my own research based on my own analysis it has been a very gradual process. Post-modernism suggests that we also include multiple feminists voices not a dominant feminist voice (white, Western, academic)

One outcome of this autobiographical process is to question the future direction of my research agenda. Another question posed is can a similar pattern be found in the research of other science educators who have concerned themselves with examining the gender issue in science? If I am isolated example then this process serves only to inform my research agenda. If my interpretation is transferrable to a larger community of science educators then there is a broader call for action. Given that I am aware that my research has been influenced by both science education and feminist theory I certainly sense the need to examine the nature of science with a focus on how can we develop a gender fair science. Post-modernism also provides us with a new framework to view the gender issue in science.

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TOWARDS GENDER-FAIR ASSESSMENT IN SCIENCE II: THE INITIAL OUTCOMES OF THE RESEARCH

Léonie J. Rennie and Lesley H. Parker

Ce document est le deuxième volet d'une évaluation des progrès réalisés dans le cadre d'un important projet sur l'égalité des sexes financé par l'Australian Commonwealth Government. Ce document met l'accent sur les résultats initiaux de la recherche. Il présente une description du développement, à partir de documentation, d'une structure visant à classifier l'orientation des sexes du contexte des tâches d'évaluation, et le partage de cette structure avec des enseignantes et enseignants et d'autres personnes responsables de l'évaluation. On y présente également certaines données sur la révision et l'adoption de la structure établie par le personnel enseignant.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

1078

TOWARDS GENDER-FAIR ASSESSMENT IN SCIENCE II: THE INITIAL OUTCOMES OF THE RESEARCH

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ABSTRACT

This paper is the second of a pair which reports progress on a major project on gender-fair assessment funded by the Australian Commonwealth Government. In this paper the focus is on the initial outcomes of the research. It presents a description of the development, from the literature, of a framework for classifying the gender orientation of the context of assessment tasks, and the sharing of this framework with teachers and others responsible for assessment. Data concerning the revision and the adoption of the framework in practice by teachers are presented.

INTRODUCTION AND BACKGROUND

In 1973, a colleague of ours, Richard Rennie, wrote an article in the Western Australian science newsletter (Rennie, 1973) questioning the relevance to real life (and real physics) of a problem involving the formula $\Phi = B.A$, at the end of which students had an abstract answer to an algebraic problem. In a subsequent issue of the same newsletter, he was admonished by a tertiary physics educator for demonstrating a "peculiar point of view" (Greenhalgh, 1972, p.5). The fact that Richard's article about $\Phi = B.A$ was "discovered" last year and reprinted in the local science teachers' journal under the heading *Flashback–Have Things Really Changed?*, emphasizes the change anticipated by the new 12th grade physics curriculum referred to in the first of this pair of papers.

Together with a number of other, mostly female, physics teachers, we have been eager to ensure that the new curriculum would really achieve its aims to "enable students to have a better understanding of many natural phenomena and their applications" and to contribute "to students' intellectual

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

development, encouraging transferable skills in practical work and intellectual pursuits, logical and analytical thinking and problem solving." We realized that a course which enables students to develop the intellectual skills to apply knowledge must be taught in a way that enables them to experience physics in a real world context and relate it to their experiences outside of school. A major impetus for the new course was the changing views about teaching and learning which recognize that students bring their own ideas to the classroom and actively construct their own interpretation of science. Recognition of students' own mind sets provides opportunity for all students to bring the diversity of their experience into the classroom, and a way by which the curriculum can become more gender-inclusive (Parker & Rennie, 1992). We also knew that the way subjects are assessed influences profoundly the way subjects are taught, and that if the goals of the new physics course are to be achieved, the assessment strategies used must also to be gender-inclusive, for example by being set in the context of real world problems and issues. Finally, we recognized an opportunity to orient physics assessment tasks towards the learning all of its students, in other words, an opportunity to make assessment gender-fair.

TEACHERS AND RESEARCHERS IN PARTNERSHIP

This paper reports our progress in the part of our research during which we worked with a group of physics teachers to develop skills and confidence in devising and implementing assessment tasks consistent with the new more gender-inclusive physics curriculum in Western Australia. The specific objectives of this part of the research were to work collaboratively with teachers to assist them in

- recognizing a gender-fair assessment task
- identifying what distinguishes a gender-fair task from a gender-biased task
- analyzing assessment tasks in terms of their gender-fairness

- modifying existing assessment tasks in order to make them gender-fair, and
- constructing and implementing their own gender-fair assessment tasks and tests.

Stage one: Describing Gender-fair Assessment

As indicated in our first paper, a major aim of our project was to review critically the research evidence about the presence, nature, identification and explanation of gender bias in assessment procedures. In achieving this aim we hoped to be able to develop a set of criteria for describing gender-fair assessment and a gender-fair assessment task. There is considerable literature about the format (the first paper touched on this) and context, of assessment tasks. We had access to literature describing the general characteristics of gender-inclusiveness in science curriculum (eg. the work of Mottier (1987) in physics and technology), and some specific discussion and analysis of how males and females succeed on tasks with different kinds of context (e.g. Erickson & Erickson, 1984; P. Murphy, 1988; Bateson & Parsons-Chatman, 1989; Chipman, Marshall & Scott, 1991). But it is not always easy to distinguish in an a priori way, assessment items in which there will be performance differences (Sudweeks & Tolman, 1993).

From our reading, we determined that the salient characteristics of the context of assessment tasks could be summarized by the terms "male-oriented", "female-oriented" and "neutral". We drafted an initial framework for describing the gender orientation of assessment tasks, containing descriptors for male, female and neutral context orientations in four categories: language, portrayal of sex-stereotypes, appeal to background knowledge and non-physics content.

Stage Two: Working with Teachers

The second stage of the research was designed as a partnership between teachers and researchers. This stage involved several steps:

(i) We conducted two workshops (in February and March, 1992), each attended by around 30 physics teachers, in association with school district inservice days. Here the background to the research on gender-fair assessment was explained, and the initial framework for describing the gender orientation of assessment tasks was presented, discussed and used to screen a number of physics assessment tasks provided by teachers. We found that the teachers were somewhat bewildered by our clear implication that at least some of their current assessment practice may not be gender-fair. Progress was, to say the least, slow. We planned a more structured approach for the next stages.

(ii) We mailed a letter to all (over 400) physics teachers in Western Australia, asking them for expressions of interest in participating in the research, and inviting them to provide examples of assessment tasks used in their schools to assess the topic of *Mechanics* at Year 11 level. We received a dozen or so responses, more than enough to base our next workshop on teachers' own assessment tasks.

(iii) Our next workshop (July, 1992) was in conjunction with the annual meeting of the Australian Science Teachers' Association in Perth, and it was attended by 20 mainly local physics teachers. Discussion was animated, but constructive, and the teachers began to modify some of the assessment tasks we had distributed into a more gender-inclusive style. Importantly, on the basis of our discussions, we were able to revise our framework for describing the gender orientation of assessment tasks ready for the next stage.

(iv) In another workshop (August, 1992) attended voluntarily by 15 physics teachers we operationalized the revised framework by developing assessment tasks, in a variety of formats (e.g. multiple choice, short

answer, extended response, etc), and with a variety of context orientations (e.g. "male", "female", etc). In a follow-up workshop with the same teachers (September, 1992), we shared their experiences in implementing the assessment strategies and tasks discussed and developed during the workshop.

OUTCOMES

As the project developed, the initial outcomes fed into the subsequent stages as we have described above. Perhaps the most significant was also referred to in the first paper: many of the teachers took some time to come to grips with the prospect of gender bias in the format and context of assessment tasks, although presented with a considerable amount of evidence from both local and international sources in this regard. It became clear during the workshops that much more time than had been anticipated would be needed for teachers to make progress in the screening and development of assessment tasks. Nevertheless, we made significant progress in the development of the framework for describing the gender orientation of assessment tasks.

The category of "neutral " gender orientation in the initial framework was especially problematic. The teachers raised a number of questions related to whether "neutral" could be equated with "decontextualized", or with apparently genderless persons in diagrams, or with the use of plural pronouns (to avoid "he" or "she"). If "neutral" was equated with "decontextualized" then this itself was problematic, since some of the decontextualized, abstract, factual items scrutinized by the teachers were deemed by them to be poor, because of a lack of realism verging on the absurd. An example demonstrates this:

> A body of mass 5.0kg and moving east at a constant velocity of 3.0m s^{-1} encounters a slope of 5.0°. Find the magnitude and direction of the minimum acceleration required to maintain a velocity of 3.0m s^{-1} up the slope. Assume that acceleration due to gravity is 9.8m s^{-2} and ignore the effects of friction and air resistance.

As a consequence of the problems with the neutral category, further investigation of the concept of "gender neutrality" was undertaken (with reference to, for example, Scott & Shau (1985) and Collins (1990)). This revealed that genderless persons, plural pronouns and the like, are generally interpreted by students to mean "male", and that females are not likely to feel included unless mentioned specifically in some way. Discussion of these points made it clear that the "neutral" category was better labelled as "allegedly neutral" because it was not gender inclusive. Thus, we had to extend the framework to include a gender-inclusive orientation. Our current framework is presented in Table 1 and we expect further work will result in further refinement.

Despite our best efforts to involve teachers in the development of the framework and to give them a sense of "ownership" for it, we did not have total success, even though teachers appeared to do their best to be cooperative. An example is the teacher who came to the last workshop with two prepared tasks about pressure and density. The first was an excellent task about pressure in blood vessels and the use of a drip solution to rehydrate a patient. The teacher described this as a task in keeping with the new context-based physics course, and then presented his "gender-fair" physics task with the throw-away line that "I don't know how to write gender-fair tasks". This task, also about pressure, began "A girl wearing shoes with stiletto heels of area.....". We hastened to explain (and we're pleased to report that some of other teachers helped us) that his first task was, in fact a good, gender-fair item, whereas the second had a female-orientation. He looked pleased, but unconvinced. Admittedly, our perusal of hundreds of physics items concerning mechanics had revealed that items with a female orientation were few and far between, but we were also disappointed that some teachers seemed to acquaint gender-fair with feminine, not masculine.

Table 1 The Gender Orientation of Assessment Items: An Evolving Classification

Criteria	Male Orientation	Female Orientation	Allegedly Neutral Orientation	Gender-Inclusive Orientation
Language	uses he, him, his	uses she, her, hers	uses they, them, their uses role (eg a sprinter .....)	uses name of person uses "you"
Portrayal of stereotypes	males in active role, females in passive role	females in active role, males in passive role	genderless people in active role (eg a scientist .....)	both males and females in active and passive role
Appeal to background experiences	relevant to stereotyped male experiences	relevant to stereotyped female experiences	not relevant to human experiences	relevant to males and females equally
Context	decontextualised, abstract	human, social,	concrete setting	human, social, environmental

1085

A side benefit of the analysis of current physics assessment tasks resulted in teachers discussing not only the gender-related aspects of the tasks, but a range of other issues pertaining to good assessment practice. The discussion proved to be valuable, although it was very time-consuming. An additional spin-off from our research is that, because we have aired some of our preliminary findings at local conferences and teacher development events, the whole issue of possible gender bias in assessment now has a higher profile. We have also been able to inject some of our thinking into the development of problem sets to be published by the local science teachers' organization (although neither our contribution nor that of the organization's gender equity committee has been acknowledged).

In the last of the workshops, teachers worked with the revised framework to analyse, amend and develop assessment tasks. They found the work challenging, and many used the opportunity to further clarify their perspectives on gender-fair assessment. Some good assessment tasks resulted, and we were able to use these and others developed in earlier workshops in a problem set distributed to teachers to use in their revision prior to final examinations in 1992. Further, we have used the tasks as a basis for the sets of gender-fair questions for the mechanics-related section of the new curriculum, and we look forward to interacting with teachers about their experiences with these. This will be a prelude to the next stage of the research in which we will focus on students and their reactions to tasks of different format and context.

CONCLUDING COMMENTS - FUTURE DIRECTIONS

This study has integrated inputs from teachers and researchers in an attempt to operationalize gender-fair, context-based assessment. Results to date are encouraging, although progress is much slower than anticipated. So far, many participants have indicated that they had found the experience of being part of the project illuminating and valuable. A few also reported that their whole

assessment practice had been enhanced, because they now looked in a more critical way at all assessment tasks, and were continuing to refine their skills in designing and using alternative forms of assessment. The assessment tasks developed during this study will be used as the basis of further research on teacher implementation of gender-fair assessment, and on student responses to assessment tasks with different formats and contexts.

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SO WHAT DID YOU DO WITH YOUR SCIENCE DEGREE? A PRELIMINARY STUDY OF CAREER PATTERNS

Dorothy R. Tovell, Ph.D. and Helen M. Madill, Ph.D.

En 1965, 45 personnes, dont 8 femmes, ont reçu leur baccalauréat en science de l'Université d'Alberta. Ces huit femmes ont récemment participé à une étude préliminaire visant à établir leur orientation professionnelle. On a eu recours au modèle de Super (1981), qui fournit une perspective de longévité du perfectionnement et du choix professionnels, et des données sur les valeurs et l'importance des rôles ont été recueillies par le biais de l'inventaire des rôles de la vie. Des renseignements sur l'orientation professionnelle ont été obtenus par le biais de questionnaires. Les données de l'inventaire d'intérêts (Strong Interest Inventory) et de l'indicateur de type (Type Indicator) de Myers-Briggs ont également été réunies. Un certain nombre de thèmes sont ressortis de l'analyse du contenu des renseignements sur l'orientation professionnelle, qui soutiennent l'utilisation de modèles alternatifs à un «pipeline de sciences et d'ingénierie qui a des fuites».

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ABSTRACT

In 1965, 45 individuals received their BSc. (Hons) degrees in the Faculty of Science from the University of Alberta; 8 of them were women. These women have recently participated in a preliminary study designed to look at their career patterns. Super's model (1981) which provides a life span perspective of career development and choice was employed and data on values and role salience were collected using the Life Roles Inventory. Information about the career patterns was obtained through questionnaires. Data from the Strong Interest Inventory and the Myers-Briggs Type Indicator were also gathered. A number of themes emerged from the content analysis of the career pattern information that support the use of alternative models to a "leaking science and engineering pipeline".

A number of incentives are now in place to recruit young women into science, engineering and technology, yet females are still under-represented in these fields. (Brush, 1991; Industry, Science and Technology Canada,1991). A variety of explanations and analogies have been used to describe this situation; a leaking pipeline is one metaphor that is commonly used (Barinaga,1992). In engineering leakage implies wastage; however, to describe those who graduated with bachelors of science degrees as waste products if they did not continue on to doctoral work is totally inaccurate!

Is there only one way to demonstrate that you are using your education? One would think so if you were to rely solely upon reports on many health

disciplines where attrition rates, vacancy rates and job turnover statistics are generally the focus. In such disciplines once one stops practising, for whatever reason, one becomes an attrition statistic very quickly. Can one simply turn off part of one's knowledge when changing a job focus or attending to such everyday tasks as running a household, maintaining a car, raising children, cooking a meal, cultivating a garden or volunteering in a myriad of community service activities? The answer of course is "no".

The case is easier to make for graduates of general or honors programs in science or arts, than it is for those from professional schools. General science or arts degrees do not lead directly to a specific profession or job, they provide an excellent education for many and a foundation for further study for others. As such, a science degree would be a good foundation for any of the activities that have just been mentioned.

The central question in this preliminary study is, is it accurate to describe women who do not use their undergraduate degrees as a foundation for further study, or those who no longer work in a field related to their undergraduate degree part of the wastage or leakage from a career pipeline? Other models are likely to be a better fit with womens' experiences. The pipeline metaphor may be applicable to manpower supply and demand models, but not to personal career development. Vocational development and choice have been studied extensively (Super 1980, 1981; Holland,1976,1973; Campbell, 1966). Super (1980, 1981) views this process from a life-span perspective and his model provides a good basis on which to review individual career patterns.

SUPER'S MODEL

Using a developmental approach to vocational development and choice Super

(1981) incorporates a life-span perspective. He suggests that people strive to implement their self-concept by choosing to enter the occupation seen most likely to permit self expression (Osipow, 1983). Behavior demonstrated to implement the self-concept is a function of the vocational stage of development. Super(1981) described 5 stages in vocational development: growth, exploration, establishment, maintenance and decline. One of the propositions in Super's model suggests that:

> Work and occupation provide a focus for personality organization for most men and many women, although for some persons this focus is peripheral, incidental or even non-existent and other foci such a leisure activities and homemaking are central (p.38).

This model also includes the concept of role salience or importance, Super states that "a successful and satisfying career may be one in which a good balance is struck between roles" (p31). Five primary roles are described: Studying, Working, Community Services, Home & Family, Leisure Activities. It is submitted that how individuals cope with multiple role functions, and strike a balance between those roles, are more likely to be the key to career patterns than a pipeline theory of supply and demand of trained scientists.

SAMPLE

The eight women honors science graduates from the class of 1965 at the U of A were invited to participate in the study. This was a sample of convenience, the group was known to Women in Scholarship, Engineering, Science & Technology and sufficient time had elapsed for career patterns to be evident. The response rate was 100%. Demographic data are outlined in Table 1.

Table 1

Demographic Data

Participant	Age	Highest degree	Marital status	# of Children (all adults)	Employment status	Science-related field
1	49	BSc(Hons)	No longer married	2	full-time	no
2	48	MSc MBA	Married	1	full-time	yes
3	49	BSc(Hons) BEd	Married	0	full-time	no
4	48	PhD MD,CCFP	Married	0	full-time	yes
5	48	BSc(Hons)	Not married	0	full-time	yes
6	51	BSc(Hons)	Married	2	full-time	no
7	48	BSc(Hons) MTS	Married	2	part-time	no
8	48	PhD	Not married	0	full-time	yes

INSTRUMENTS

Three inventories were used: the Strong Interest Inventory (Strong, 1985), designed to compare the work interests of an individual with the interests of people who are "happily employed in a wide variety of occupations" (Hansen, 1984, p.1); the Life Roles Inventory (Fitzsimmons, Macnab, Casserly 1985), designed to measure career values and role salience [importance]; the Myers-Briggs Type Indicator (Myers & McCaulley, 1989), designed to measure preferences on four basic scales, attitude, perception, judgement and style of dealing with the outside world. The reliability and validity for each of these instruments is within acceptable limits. Three questionnaires that had been

used in previous research were employed, a record of the career pattern, a description of 'Your Ideal Job', and a description of 'The Plus & Minus Sides of the Current Job'.

DATA ANALYSIS

Given the small size of the sample and the nature of the research question descriptive statistics were used for the quantitative measures (SII, LRI, MBTI) and a qualitative measure, content analysis, for analysis of the career pattern data.

RESULTS

The SII was used to determine the degree to which each participant's interests were compatible with those in science (biochemistry) or science related fields (medicine) and the degree of similarity between the profiles. It would be expected that those with a strong scientific orientation would endorse the Investigative (I) theme where they can use their analytical skills, mathematical aptitude, writing skills and scientific ability. Table 2 shows that all participants started their careers in investigative occupations; four of them continue to be employed in that area.

Table 2
SII & MBTI Codes and Employment Data

Participant	Strong Code	MBTI	Employment	
			First Position	Present Position
1	I - C - R/S	ISTP	Laboratory Technician (analytical chemistry)	Service Representative (utilities)
2	I - A - R	INTP	Computer Programmer	Management (banking)
3	E - A - I	ESTJ	Science Teacher (high school)	Management (banking)

4	I - A - R	INTP	Post-doctoral Fellow (chemistry)	Physician,Department Director (family practice)
5	C - I - R	ISTJ	Laboratory Technician (research chemistry)	Translator (free-lance)
6	C - A - I	INFJ	Laboratory Technician (lung function)	ESL Teacher (college)
7	C - S - I	ENTJ	Systems Analyst	Chaplain (hospital)
8	A - I - S	INFP	Post-doctoral Fellow (virology)	Program Coordinator Sessional Lecturer (university)

The MBTI was used to determine the participant's preferred style and the degree of similarity between profiles. It would be expected that those with interests in scientific areas would endorse Introversion (I) and Thinking (T), a focus on ideas, impressions, objective analysis and logic. Participants' codes are listed in Table 2.

The LRI was used to determine the values and role salience of each participant, the level of commitment and role value realisation were of particular interest. When considered as a group, participants highly endorsed: Personal Development, Social Relations, Ability Utilization and Autonomy, Prestige and Altruism, Achievement and Creativity.

When role salience [importance] is considered, all participants are committed to the Working role. Five of the participants are more committed to this role than any other. The Home and Family role is also important, but it is not the central role for the majority. It should be noted that where these participants have children, they are all now over 20 years of age. The Working role is also where the majority (7) of participants see implementing their values either now or in the future.

Participant's listed the plus and minus sides of their current jobs. The content

analysis and rank ordering of themes on the plus side is as follows: job satisfaction (8), independence/flexibility (6), co-workers (4), financial/benefits (4) and working conditions (3). On the minus side: bureaucracy (6), lack of job satisfaction (6), co-workers (4), working conditions (3) and financial/benefits (2).

The eight participants in this study have held a total of 55 positions in the 28 year period. The most frequently cited reasons for choosing these positions were: opportunity (28), promotion/transfer (10), family/child related (6), geographic relocation (5), husband related (3) and volunteering (3). [Note that some participants currently hold more than one part-time position]. Of the 42 positions they have left, the reasons cited were: job termination (13), opportunity (10), promotion/transfer (5), family/child related (4), geographic relocation (4), study (3), husband related (3).

DISCUSSION

The central question in this preliminary study was: is it accurate to describe women who do not use their undergraduate degrees as a foundation for further study or those who no longer work in a field related to their undergraduate degree as wastage or leakage from a career pipeline? From the results outlined above there is little or no support for the use of such a model for the following reasons:

* all participants are employed and in relation to their level of value endorsement, the personal development/achievement, social and independence components are of highest importance.
* the Holland codes (SII) of all participants describe individuals whose interests are compatible with those in investigative occupations. Therefore it is unlikely that any participant's initial career choice was inappropriate.

* changes in jobs were more likely to be due to available opportunities rather than home and family circumstances.
* four participants (50%) continue in science or science related fields. The remainder have found alternate occupations which permit expression of their self-concepts. Vocational interests, as mirrored in their Holland codes, support this divergence.
* work provides the focus for the majority of the participants and all appear to have struck a sufficient balance between roles to maintain successful and satisfying careers.
* the career patterns of these participants appear to be similar to that noted in allied health professions (Madill, Brintnell, Stewin, Fitzsimmons & Macnab, 1985).
* a linear career pattern is not apparent. The pipeline, should it exist, is branching, not leaking!

Super (1981) stated that each individual has the potential to enter a number of occupations by virtue of their abilities, interests and personalities. As results of this preliminary study show, these eight women entered and qualified for science degrees, but did not demonstrate linear career patterns in science. Super's model of vocational development describes a series of stages in which "a recycling process takes place in the transition from one stage to the next involving minicycles of new growth, reexploration, and reestablishment" (p.37). Semi-structured interviews are presently being conducted to see whether the participants' perceptions of their career development are consistent with such a model.

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THE INTRACTABILITY OF GENDER SEGMENTATION IN THE WORKPLACE IN AUSTRALIA

Kathy Banks

En 1990, les femmes formaient 41 % de l'ensemble de la main-d'oeuvre australienne. Dans un pays où les femmes ont le droit de vote dans les élections fédérales depuis 1902, la lutte pour l'indépendance économique et la justice sociale dans les milieux de travail fut difficile à gagner. Dans les syndicats «axés sur les aptitudes» et dominés par des hommes du «paradis des travailleurs», des employeurs conservateurs et un mode d'arbitrage enchâssant formellement la notion de «salaire masculin» ont favorisé un climat où les questions d'équité et d'accès, plus particulièrement dans les programmes d'études et les emplois traditionnellement masculins, ont été reconnues plutôt tard que tôt. Les nombreuses initiatives des gouvernements fédéral et des États de la dernière décennie (et d'autres programmes d'intervention tout aussi nombreux dans les écoles, les universités et certains organismes professionnels) tentent encore de corriger la situation. Ainsi, l'Australie enregistre actuellement le plus haut niveau de segmentation des sexes des 22 pays membres de l'Organisation de coopération et de développement économiques (OCDE). De récentes études gouvernementales ont démontré que la segmentation des sexes dans les milieux de travail a en fait légèrement augmenté en Australie au cours des vingt dernières années en dépit des nombreuses initiatives visant à modifier cette tendance.

Ce document examine le rôle historique des gouvernements australiens (tant fédéral que des États) dans l'enchâssement de la segmentation des sexes dans les milieux de travail, et la raison pour laquelle les stratégies gouvernementales de la dernière décennie n'ont pas contribué à améliorer la situation. De plus, ce document examine certaines des raisons pour lesquelles ces niveaux élevés persistent à être élevés et tente de découvrir des possibilités de mettre au point des stratégies visant à augmenter les choix des jeunes filles et des femmes en matière d'éducation et de carrière au sein des domaines où la segmentation des sexes est encore considérable.

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1098

THE INTRACTABILITY OF GENDER SEGMENTATION IN THE WORKPLACE IN AUSTRALIA

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ABSTRACT

In 1990 Australian women made up 41% of the total labour force. In a country where women voted in federal elections in 1902, the battle for economic independence and social justice in the workplace has been difficult to attain. In the "workers paradise" male-dominated "skills-based" unions, conservative male-oriented employers, and an arbitration system which formally entrenched the notion of a "male wage", fostered a climate in which equity and access issues particularly in non-traditional education and employment for women were recognised later rather than sooner. The many initiatives of both federal and state governments in the past decade (and various other intervention programs underway at schools, universities and some professional organisations), have yet to redress the situation. As a result, Australia currently records the highest levels of gender segmentation among the 22 member countries of the Organisation for Economic Co-operation and Development, (OECD). Recent government studies suggest that gender segmentation in the workplace has actually increased slightly in Australia over the last twenty years despite the many iniatives aimed at reversing the trend.

This paper examines the historical role of Australian governments (both State and Federal) in entrenching gender segmentation in the work place and, during the last decade, why government strategies have failed to ameliorate the situation. The paper investigates some of the reasons why those high levels continue to occur and attempts to identify opportunities to develop strategies which will broaden girls' and women's education and employment options in highly gender-segmented labour markets.

INTRODUCTION

As recently at the early 1970s, most of Australia's daily newspapers were still heading their employment columns "Jobs for Men and Boys" and "Jobs for Women and Girls" (*Sydney Morning Herald*). Unable to discard at one stroke the outward signs of institutionalised gender segmentation in the workplace, employers and newspapers then adopted for some years the headings "Jobs of Interest to Men and Boys" and "Jobs of

Interest to Women and Girls". The tardy removal of such obvious gender discrimination in employment is not difficult to understand when viewed in the context of Australian history. Indeed, such headings, and the attitudes underpinning them, persisted at least partly due to a strong labour movement and a government administered labour arbitration system which together served to perpetrate the notion of jobs for males and jobs for females.

In 1904, Australia's newly formed Federal government enacted the Commonwealth Conciliation and Arbitration Act which empowered an Arbitration Court to hear disputes and seek resolutions between employers and unions. This court became the official voice on industrial relations matters within Australia and continues to be the source and guardian of attitudes and opinions in this arena. In 1907, through an Arbitration Court ruling, Australia became one of the first countries in the world to establish a national minimum wage for (male) workers. This wage was based on the expectation that an average male breadwinner supported a dependent wife and three children. The decision excluded all female workers no matter how many dependents they supported. This legislation, once hailed as a landmark piece of social reform, is now viewed by women living at the other end of the twentieth century as a stumbling block to progress rather than a foundation on which to base further reform. Indeed, the National Women's Consultative Council (NWCC) views the basic wage case of 1907, the attitudes it enshrined, and the precedents it set as a long-standing hurdle in the way of equity and social justice in the workplace:

> This enshrined an inequitable system of work valuation into Australia's wage fixing process. Unfortunately the legacy of this discrimination is a major barrier to achieving pay equity for women today. (NWCC, 1990)

Modern iniatives in providing a measure of wage justice and in redressing imbalances in male-gendered employment, it may be argued, began in Australia in 1969. In that year the Conciliation and Arbitration Commission recognised equal pay for equal work, and in 1972 granted a case of equal pay for work of equal value. Despite the aura of reform, the Commission continued to cling to its entrenched notions of a male

breadwinner and its decision was framed so narrowly that only 18% of adult female employees were able to put forward successful cases under it. (NWCC, 1990) When a test case for comparable worth was put to the Commission in 1985 and rejected, its perceived status as a reforming body was clearly officially ended. The inability of groups to present legal cases for gender equity in paid employment under the 1972 legislation and the rejection of comparative worth in Australia in 1985 dashed hopes, at least for the foreseeable future, that traditionally female areas of employment would reflect remuneration levels commensurate with skills levels. Many government policymakers and other organisations, recognising this situation, have sought to attract females into non-traditional areas of education and employment and their efforts take form in government iniatives, and in programs at schools, universities and professional associations. Despite their dedication, the goal of breaking down the incidence of gender segmentation in the Australian work force is somewhat daunting.

THE EXTENT OF THE PROBLEM

The level of gender segmentation in the Australian work force places Australia last out of twenty two OECD countries according to the latest figures. This means that Australia falls not only behind English speaking countries such as the United States Canada and New Zealand, but also behind countries as disparate as Portugul, Turkey, Italy, Finland, Belgium, Ireland and Spain. (Dept. of Industrial Relations 1991) In Australia 55% of women are concentrated in only two occupational groupings; clerks and salespersons and service workers. Fewer than 25% of women workers are classified as skilled compared to 50% of men. Only 18.5% of women employees are professionals or para-professionals and half of these are located in traditionally female employment areas such as teaching and nursing. (Australian Bureau of Statistics, [ABS] 1990) The Australian Department of Industrial Relations (DIR) and the New South Wales Department of Industrial Relations and Employment (DIRE) have both noted that gender segmentation has actually increased over the last twenty years despite numerous and varied efforts to redress the situation. (DIR, 1991; DIRE 1989).

SOME GOVERNMENT INIATIVES

Despite imperfections already noted within Australia's policymaking and legislative bodies, to date these have proved the only mechanisms available for developing and introducing the scale of social change required to impact on levels of gender segmentation. State and Federal governments in particular have developed iniatives which attempt to broaden girls' and women's choices in both subjects studied and in employment pursued. These include the Federal government's 1987 National Policy for the Education of Girls in Australian Schools, its 1988 Australian Women's Employment Strategy and its 1990 Higher Education Policy. State governments have also developed a range of strategies in education and employment practice to broaden women's work opportunities. Notwithstanding the wide range of government reports and iniatives to redress the situation and the undoubted commitment of some policymakers and legislators, the House of Representatives Standing Committee on Legal and Constitutional Affairs in its 1992 Report into Equal Opportunity and Equal Status for Women in Australia noted some shortcomings:

> The Committee was disappointed that the sample of reports of the success or otherwise of government iniatives indicated a lack of commitment in some portfolio areas to address the needs of women...

State and Federal government legislation, policies and strategies (only a few of which are mentioned here) are wide ranging and operate in schools, technical colleges, universities and the workplace. In some ways, however, they run ahead of long-held attitudes and assumptions by many influential groups in the community. Government policies aim to bring about a higher level of equality for women in the workplace and in particular to break down Australia's high levels of gender segmentation. Notwithstanding this, many aspects of legislation and in particular the policies aimed at reducing gender segmentation in the workforce have been less than successful in their implementation. This is because they must survive in a society which receives, at best, conflicting messages about women's status and appropriate place in the workforce and which finds the *status quo* not only comfortable but still widely acceptable.

CONTRIBUTING FACTORS

A number of factors may be identified as contributing to the slow pace of gender equity reform in the workplace. There can be little doubt that prevailing attitudes in influential sections of the community are a major factor. The Department of Industrial Relations has stated unequivocally that "industrial and occupational segregation have occurred because of continuing assumptions regarding what is appropriate work for men and women". (DIR, 1991) Community attitudes and assumptions are frequently deeply ingrained and often prove difficult to shift. This is especially so if they contain echoes of national myths or provide a comforting illusion of stability and certainty in a world that is in fact in a state of rapid change. Inappropriate attitudes and assumptions about women and work may be fostered by parents, peers, teachers, advertising bureaus, the media, employers, unions, the judiciary, governments, and many other sectors within a society. Each, in its interaction with a developing individual, presents attitudes and assumptions as neutral and as the only way to interpret the world. The difficulty is to be found in the frequently unperceived bias these attitudes and assumptions contain and in the wide sphere of influence of many of these agencies.

The extent to which prevailing male-dominated attitudes and assumptions continue to be sustained in Australia are clearly demonstrated by five incidents which occurred in a recent three month period. They included three television advertisements, a billboard advertisement and a statement by a Supreme Court judge in a "rape in marriage" case. The incidents covered four of Australia's most populous states and were perpetrated by a State Government (in the persona of a Supreme Court judge), a State Government tourist bureau, a national chain of women's fashion clothing stores, a national brewery and an international lingerie manufacturer. In each incident women were presented to wide sections of the general public variously as possessions with no rights, as sex objects, as brainless unreliable workers, and as objects of fun and derision.

Linguist Deborah Tannen argues that while women use language and conversation to make connections and reinforce intimacy, men use it to protect their independence and

negotiate or enforce their status in what they perceive as society's hierarchy. (Tannen, 1991) The Yankelovich Monitor surveys, a large poll carried out in the United States over the past twenty years, found that the majority of men still identify themselves as the "breadwinner" and nominate "being a good provider" as the most important attribute of masculinity. (Faludi, 1991) Widespread attitudes and beliefs such as these place the social justice issue of economic independence for women strangely at odds with many men's ideas of what it is that constitutes masculinity. Resolving men's and women's differences in viewing the world and each gender's place within it at this fundamental level, then, is central to ensuring more open attitudes about women and work are achieved by greater portions of the community.

The attitudes and assumptions which act to retain the workforce as it is and to discourage wider employment opportunities for women have so far been demonstrated to have historical antecedents and to appear in advertising, in judicial rulings and indeed in the general community. These attitudes and assumptions are reinforced daily in the stereotyping of characters in books, particularly text books, in music, art , film, theatre, the print media, computer games and sport. Indeed they permeate society in a way that approaches the saturation levels of propaganda. Technology is not necessarily a neutral player in this process. Positive messages about women's wider participation in the workforce, and there are a number of these, can often be swamped in the unthinking "hype" and stereotypes of mass communication.

Existing attitudes and assumptions fuel two further factors which contribute directly to gender segmentation. The first of these is the significantly higher percentage of women in part-time employment than men. In Australia women comprise 78% of a total part-time workforce which is rapidly expanding. (ABS, 1990) This predominantly female workforce provides employers with a docile and flexible workforce which has little access to in-house training, promotion or full-time work. In addition, employers "on-costs" are minimised because part-time and casual workers rarely receive compensation for statutory holidays, sick days, penalty rates or employer assisted pensions available to full-time workers.

The second factor is the role of sexual harassment in discouraging girls and women from commencing or continuing with non-traditional education and employment. A number of studies have identified sexual harassment in the workplace as a major factor in women's decision to leave non-traditional employment or to refrain from choosing this option in the first place. More recent studies have noted the high incidence of gender-based harassment in schools and universities. (DEET, 1992; Australian Education Council, 1992) The impact of this behaviour and the sometimes inappropriate attitudes demonstrated by fellow students, teachers and employers about girls' and women's role in non-traditional areas is reflected in the statistics and anecdotal evidence of these reports. They indicate a link exists between such behaviour and the relatively low levels of participation and retention in non-traditional education and employment by girls and women.

CONCLUSION

Gender segmentation in the Australian workforce has a historical foundation which, until comparatively recently, has been cemented in place by formally sanctioned industrial courts issuing legislation at one time considered socially reforming. This has provided a framework in Australian society in which traditional male attitudes and assumptions about the place of women in society in general and in the workforce in particular have been sheltered from change. These factors have ensured that the breakdown of gender segmentation in the workforce remain intractable because they require simultaneous intervention on many fronts and at many levels. To be effective, legislative reforms and strategies already developed by government policymakers need be vouched in ways which will counter the widespread assumptions and attitudes in the community which are delaying reform implementation or causing it to be piecemeal.

Most women and some men consider the equity and social justice aspects of providing girls and women with access to wider opportunities in education and employment paramount. It is, and in a perfect world all would comply on these arguments alone. Nevertheless many of the most influential employer groups and indeed some significant

areas of the general public remain unmoved by social justice and equity arguments despite legislation. In a time of economic upheaval and great workplace restructuring, however, they are increasingly persuaded by arguments of cost efficiency and the effective utilisation of personnel resources. Employers are seeking to attract talented and innovative employees to remain competitive in difficult economic times. The Australian Federal government has calculated that 70% of those in receipt of government provided welfare in Australia are women. (ABS, 1990) Change (when it does occur) is more often being motivated by economic considerations rather than by concerns of equity and social justice. This may bother some reformers who wish to bring about social change for the "right" reasons. Yet, paradoxically, tapping into this concern may provide social reformers with an effective strategy for transforming behaviour and hence overcoming existing attitudes and assumptions. Employers are beginning to recognise the talent they have left untapped through discriminatory processes. Recently a major employer in Australia, BHP Steel stated:

> The company is committed for reasons of equity and just good business sense, to work hand-in hand with government and learning institutions in tapping the most important resource, people; half of whom just happen to be women. (BHP Steel, 1991)

Much of the legislation and many of the policies and iniatives which have the potential to introduce social reform in education and employment in Australia are already in place. They await behavioural change and reformed attitudes, however motivated, among key sections of the community if Australia's record in work place gender segmentation is to be improved.

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GENDER BIASED MATHEMATICS

Silvia Chavarria

Les mathématiques sont conçues au sein de la société de telle façon qu'il est impossible qu'elles soient sans distinction de sexe. Dans ce document, je tente de prouver l'existence de cette partialité dans le domaine des mathématiques et de clarifier et d'analyser certaines des conséquences de ce parti pris contre l'autre sexe.

Pour atteindre l'objectif de ce document, j'accepte le fait qu'il existe une différence entre les hommes et les femmes et les filles en ce qui concerne leur participation et/ou leurs réalisations dans les programmes et professions de mathématiques. Dans ce document, j'examine tout d'abord les philosophies mathématiques et systèmes de croyances différents en ce qui concerne la nature des mathématiques, puis je définis ce à quoi des mathématiques plus «féminines» devraient ressembler. Enfin, j'insiste sur le fait que la façon dont les mathématiques ont toujours été définies et enseignées ne peut inclure une perspective féminine, étant donné que les femmes n'ont pas participé à la définition et à création des mathématiques.

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GENDER BIASED MATHEMATICS

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ABSTRACT

Mathematics is socially constructed, so it can not be neutral. With this paper, I intend to show how mathematics is gender biased, and to clarify, expand, and analyze some of the consequences or this bias.

To reach the goal of this paper, I am going to accept as a truth that there is a gender difference in women's and girl's participation and/or achievement in mathematics and mathematics-based courses and careers. First, I am going to review the different mathematical philosophies and belief systems about the nature of mathematics, situating this paper within these frameworks. Second, I am going to define what "feminine-connected" mathematics ought to be like. Finally, I am going to argue that the way mathematics traditionally has been defined and taught does not include a feminine-connected perspective, since women have not contributed to the definition and determination of mathematics.

INTRODUCTION

I believe that mathematics, like all human endeavor, is socially constructed. I believe that mathematics is not just the set of definitions, axioms, and the logic that relates them, as formalists have traditionally described it. Mathematics is also its history, practice, "doings", and applications (e.g. Ernest, 1991; Lakatos, 1976). It is from this perspective that I view the term mathematics in this paper.

I believe that there is a women's way of learning, and the way mathematics has been constructed has not taken this into account. Women and feminine characteristics have been left out of academic or western mathematics. Because mathematics does not reflect their values and beliefs it is an alien subject for most

women. This fact could be a very important factor in women's underachievement in this subject and underrepresentation in careers with strong mathematics, science or technological bases.

MATHEMATICS AS A SOCIAL CONSTRUCTION

The claim that mathematics is a social construction is based on a fallibilist conception of mathematics as opposed to an absolutist one. Three main philosophies of mathematics have been included under the title absolutist: logicism, formalism, and constructivism. Even though there are differences among them they all share the belief that mathematics is a body of "certain and unchallengeable truths" (Ernest, 1991, p. 7). These truths are considered to be objective, value-free, universal, and independent of any context. Mathematics is discovered, not created. The absolutists believe that each new truth is derived through socially accepted logical rules, from an initial set of truths. A basic criticism of this theory is that logic can only transmit a truth that already exists; it can not provide one. This lays the burden of certainty on the initial assumptions. These assumptions and the logic on which they are based must be socially accepted. Lakatos (1976) argued that, since this basic set of assumptions can not be proven, but have to be accepted by social entities, they must be considered a set of beliefs.

The fallibilist view of mathematics supposes that mathematics is fallible, so it can be revised and changed. Two main philosophies of mathematics are based on fallibilist premises: quasi-empiricism (Lakatos, 1976) and social constructivism (Ernest, 1991). Their main postulates are that mathematics is fallible, that it is hypothetico-deductive, that history is central, and that mathematics is created, not discovered. Informal mathematics is valued since it is through a process of social acceptance that subjective or informal mathematics becomes objective mathematics.

Social constructivists claim that mathematics can be understood better if its history and its social production, definition and organization are taken into account. They believe that, through history, the different groups in power have determined and selected what ought and what ought not be considered proper mathematics (Davis & Hersh, 1981). They believe that mathematics has been tailored to answer the needs of the groups in power, being a powerful and useful tool for reaching their goals. It has served the purpose for which it has been constructed.

Social constructivists consider that women, as a group, have not been part of the power structures, even though some individual women have had transitory positions of power. Similarly, some women, adapting themselves to the power structure, have been successful in academic mathematics. These women's success in mathematics does not alter the fact that, at least in the western culture, mathematics has been identified with masculinity and power, having been defined by a power structure, which has been mostly male. Women have had very little power in determining either the mathematical problems and issues or the mathematics that has been generated to answer them.

To believe that mathematical expressions like "one plus one equals two" are neutral, universal, independent of society and culture, and that this implies that mathematics is value-neutral, ignores the context and the situation that motivated the mathematical finding. It negates the differential meanings and interpretations of different cultures. Further, to believe that if a mathematical expression is neutral implies that mathematics itself is neutral, is to define mathematics as a set only of unquestionable axioms, definitions and logic.

FEMININE CONNECTED-LEARNING

Feminist researchers have tried to determine if there is a feminine mode of development and of learning (e.g. Belenky,

Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1983). They have based their research not on what is believed or idealized to be feminine, but on what they have found while observing and talking with females. They claimed women learn in a feminine-connected way, as shown in the following set of ideas. This does not mean that all women learn the same way or that men are excluded. Since the researchers are not making claims about males, there is no presumption that the opposite poles characterize males.

1. In feminine-connected learning there is a need for confirmation: of the power to learn, of belonging to a community, of being an intelligent, capable human being. Since women have not usually been seen as sources of official or legitimate knowledge, their problems, interests and values have not been reflected in traditional learning situations.
2. There is a need to relate what is learned to personal experience: this need should be valued and recognized as important. If the problems that are normally posed during mathematics classes intersect with the students' lives, this could be accomplished. Since most of women's life situations have not been officially or institutionally integrated as societal concerns, the possibility of this happening is very slim. Feminist researchers have argued about the need for women to speak in their own voice.
3. Feminine-connected learning rejects the idea that the ultimate authority has to be external to the student. The teacher, textbook, mathematics, or mathematicians should not be the only authorities. Valuing of the personal experience and the intellectual capacity in an atmosphere of trust, supports the student's internal authority. So in an authoritative, hierarchical learning situation, females are going to fade out, to respond with silence.
4. There is a need for learning to take place in cooperative,

non hierarchical situations. This too, validates the student's internal authority over an external one. In feminine-connected learning, sense making takes place through negotiation, not through a hierarchical imposition.

5. Feminine-connected learning requires that knowledge should not be presented in a fragmented way. Knowledge has to be related in an integral way to previous knowledge and experience for learning to take place. Because of this, learning takes place more readily in a relevant, contextual situation.

6. Feminine-connected teaching has to be based on the student's, not on the teachers', previous knowledge.

7. Feminine-connected learning argues that an atmosphere of trust is needed for learning to take place. This implies that what the student knows, not what she/he does not know ought to be valued.

8. In feminine-connected learning, abstraction is valued as a tool that clarifies experience. Abstraction is questioned when it precedes experience or when it negates it.

9. In feminine-connected learning, objectivity is understood as acceptance of the subjective: it is not value-free.

As stated before, the researchers quoted above maintain that women learn better in a feminine-connected way. Relating this statement to 1) what is being claimed by situated cognition, that how something is learned is an integral part of what is learned and 2) the belief that mathematics itself is not just the set of definitions, axioms, and logic, but the doing, the applications and the social context, implies that if mathematics is not considered feminine-connected, then we can say mathematics is gender biased.

TRADITIONAL MATHEMATICS IS NOT FEMININE-CONNECTED

-Lack of Historical and Social Context: Historically mathematics has been presented as infallible, unchangeable, objective, neu-

tral, universal, and value-free, as an abstraction of what it really is. The formalist mathematics structure has lacked the context of its construction. The way mathematics is presented to the public is not as it was developed, or as a solution to a problem, but as a piece of an immutable structure. Putnam, Lampert, and Peterson (1989) discuss how the Hindu and the Greek differed in what they considered doing mathematics. The goals of the Hindu during the development of algebra were to empower the layman, to enable him to solve his everyday computational problems. They considered that obtaining a solution by algorithmic approaches or by the trial and error method was doing mathematics. On the other hand, the Greeks had a very rule bound, axiomatic mathematics intended for the elite. The Greek influence has helped determine the content, the solution strategies, the deductive processes, and the curriculum that the western culture has valued.

-Decontextualization and Abstraction: Abstraction has been commonly understood in classroom situations as equivalent to decontextualized and/or symbolic. Conventional mathematics has been decontextualized, emphasizing the application of abstract propositions devoid of the context that originated them, be they historical, social or cultural. Chipman (1988) found that the context of a mathematical situation affects its interpretation and solution, that the context defines it and is not just an addition, the icing on the cake. Given the same mathematical structure, she determined that students' responses varied according to the context or story in which the problem was situated.

-Competitiveness: Traditional teaching of most subjects, mathematics included, has used a very competitive model. Moreover, the language that has been associated with doing of mathematics is competitive and aggressive. Mathematics has unofficially been used as a measure of intelligence and as a filter for entering

into careers, emphasizing to students the need for excelling in this area. The search for the best or the only answer has also emphasized competitiveness in mathematical classrooms, not valuing valued the different personal experiences or the need for negotiating meanings, which are required for a connected learning situation.

-Development of Mathematics: The areas developed in mathematics are not independent of their environment, be it social or physical. More research is supported and initiated in areas where research is already under way. As stated before, historically, in the western culture, women's sphere has been the private domain: women had little power to determine what things were done and how things were done. The influence of social, political, and economic situations in determining the areas to be developed is shown by studying the development of mathematics during any of the wars.

-Valued and Assessed: One of the ways students learn what is valued in a classroom is by observing what and how it is assessed. Mathematics assessment has emphasized to the student what she/he does not know, not what the student knows. Essay type testing that provides for a scenario to show what a student knows has not been encouraged in mathematics. This methodology does not encourage feminine-connected learners who seek confirmation and an atmosphere of trust.

-Objective and Value-Free: Academic mathematics values objectivity. Subjective statements are not considered worthy of study. Because of this valuing, subjectivity has been "objectified" to be acceptable in several mathematics areas. Since this is not a premise of formalist mathematics, women who value subjectivity are at a disadvantage.

-Fragmented, Without Details: The traditional mathematics curriculum presents mathematics in a fragmented form. In school,

mathematical areas are treated as separate, even though they are part of a larger mathematical structure. As stated before, women learn better in a connected situation, where the topics are interrelated and their personal knowledge and experience is valued.

-Experience Not Validated: Learners can not be confirmed easily in an area that invalidates their personal experiences. This can be seen in the development of mathematics. Mathematics that is being applied and used by different individuals, cultures, or even other sciences, has not been accepted easily into the mathematics structure.

-Only One Way of Doing Mathematics is Valued and Officially recognized: deduction. However, if this was true, the only growth that mathematics could have had would have been the proving of more theorems through mechanical deduction of previous ones (Lakatos, 1976). The lack of acceptance of different ways of doing has led the mathematical community to reject the proof of the four color theorem for several years. The narrow definition of what mathematics is, invalidates the different personal ways that could be and are being used for working in mathematics, especially by women.

CONCLUSIONS

One of the basic feminist principles requires the acceptance of one's own biases and belief structures. Only through an examination of our situation can we make informed decisions and plan for change.

In this paper I have shown how mathematics is gender biased. If mathematics is viewed from an absolutist perspective: immutable, static, unchangeable, universal, the previous statement would have a very pessimistic and disempowering meaning for women. From my fallibilist position, the statement demands that mathematics be revised to incorporate a feminine-

connected point of view. Knowing the limitations, biases, and belief structure of formalist mathematics, helps us to come to grips with it and shows us ways to change it.

Historically, instead of changing mathematics, women have been asked to change their mode of learning. As a policy, women have had to adapt themselves to the existing structure, to negate their femininity. Instead of adapting a tool to the user, the user had to adapt herself to the tool. This would make sense if mathematics was effective for all groups except women. Test results like NAEP in the U.S.A., Bachillerato de Matemática in Costa Rica, terminal tests in Great Britain, show that mathematics is not answering the needs of the population in general and females in particular. So there is no support for the belief that it is females, not mathematics, who ought to change.

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WOMEN AND ENGINEERING: A CRITICAL RESEARCH REVIEW

Valerie Norlen

Je laisserai aux autres la tâche de (i) documenter les thèmes majeurs des écrits toujours plus nombreux sur les sexes et la technologie; (ii) résumer les explications sur l'absence et la ségrégation des femmes dans les domaines techniques; et (iii) découvrir les interventions et solutions apparemment les plus prometteuses pour éliminer les inégalités actuelles entre les sexes.

Ma contribution vise à réunir deux domaines de la recherche généralement différenciés. Le premier comporte une longue histoire de remise en question de l'hypothèse comme quoi la technologie est socialement neutre, autonome et inévitable. Les analyses de Karl Marx, Harry Braverman et Jacques Ellul ont démystifié la «boîte noire» de la technologie, révélant la façon dont elle découle des intérêts politiques et économiques. Le deuxième domaine de recherche met l'accent sur la relation des femmes avec la technologie et commence avec des analyses individuelles microsociologiques d'attributs de personnalité, de stéréotypie des sexes et de socialisation de l'enfance. D'autres recherches sur les femmes dans les milieux de travail techniques ont indiqué une ségrégation nette des femmes dans les postes bénéficiant d'un prestige moindre, d'un salaire inférieur et de moins de possibilités d'avancement. À cela s'est ajoutée la compréhension d'une «culture de la technologie», qui a contribué aux expériences des femmes relatives au sexisme, à la discrimination, à l'isolation sociale et aux sentiments de conflit entre leur identité personnelle «féminine» et l'identité professionnelle «masculine». Ce n'est que récemment que les universitaires féministes ont établi un lien entre les analyses marxistes de la technologie et les considérations patriarchiques pour comprendre le rôle des sexes dans la professionnalisation et l'institutionnalisation de certaines professions techniques telles que le génie. De telles analyses ne font que commencer à nous aider à mieux comprendre le quotidien des femmes ingénieures en milieu de travail et à la maison.

Ce document tente de combiner les perspectives individuelles et structurelles passées, c'est-à-dire, d'utiliser une macro-orientation pour expliquer la façon dont la pratique du génie est comprise au micro-niveau. Bien que j'établisse une relation dialectique entre ces deux niveaux, j'insiste plutôt sur la relation structurelle parce qu'elle définit les relations de pouvoir entre les individus. Une telle orientation guide mes études de doctorat sur les imprévus professionnels -- tant individuels que structurels -- qui ont un impact sur le cheminement de carrière des femmes ingénieures et des hommes ingénieurs, et ce que ces imprévus signifient dans la vie quotidienne des hommes et des femmes en génie. Ce document prend la forme d'une proposition, avec un sujet de recherche et une suggestion de méthodologie, et requiert des commentaires.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

WOMEN AND ENGINEERING: A CRITICAL RESEARCH REVIEW

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To others I will leave the task of (i) documentating major themes in the growing body of literature on gender and technology; (ii) summarizing the explanations offered for women's absence from and segregation within technical fields, and; (iii) pinpointing those interventions and solutions which seem most promising in redressing current gender inequities.

My contribution attempts to bring together two generally separate streams of research. The first strand has a long history of challenging the contention that technology is socially neutral, autonomous and inevitable. Analyses by Karl Marx, Harry Braverman and Jacques Ellul have demystified the 'black box' of technology, revealing how it is shaped by political and economical interests. The second strand of research focuses on women's relationship to technology, and began with individual, micro-level analyses of personality attributes, gender stereotyping and childhood socialization. Further research on women in technical workplaces indicated an emerging segregation of women into positions with lower prestige, pay and possibilities for promotion. To this was added an understanding of a 'culture of technology' which contributed to women's experiences of sexism, discrimination, social isolation, and feelings of conflict between their 'feminine' personal identity and 'masculine' work identity. Only recently have feminist scholars combined Marxist/class analyses of technology with considerations of patriarchy to understand the role of gender in the professionalization and institutionalization of certain technical occupations like engineering. Such analyses have only begun to inform our understanding of how women engineers experience their everyday work and home lives.

My contribution to this conference attempts to combine past individual and structural perspectives, that is, tries to use a macro orientation to inform an understanding of how the practice of engineering is experienced at the micro-level. Though I posit a dialectical relationship between these two levels, emphasis is placed on the structural because it defines the relations of power within which individuals maneuver. Such an orientation directs my current doctoral studies which investigates the career contingencies -- both individual and structural -- that effect the career paths of both women and men engineers, and what these contingencies mean for the daily lived experiences of men and women in engineering. My paper will take the form of a proposal, outlining a research topic, indicating the proposed methodology, and asking for critical feedback.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

RECRUITMENT AND RETENTION INITIATIVES FOR WOMEN IN TECHNICAL FIELDS

Marcia Braundy

Le survol des stratégies et activités actuellement entreprises en vue d'accroître et de rehausser la participation des femmes dans les professions techniques fournit un large éventail des initiatives gouvernementales, des employeurs/syndicats et comunautaires. On ne peut sous-estimer l'importance de fournir une formation exploratoire initiale aux femmes qui possédent peu d'expérience dans le domaine. Dans une culture où les femmes sont loin d'être encouragées à entrer dans les domaines techniques, l'expérience pratique est essentielle pour faire des choix de carrière informés et acquérir l'assurance nécessaire pour réussir dans de tels domaines. Une fois la formation technique terminée, des mesures spéciales risquent de devoir être prises pour améliorer les pratiques d'embauchement. Une fois au travail, les stratégies de formation et de soutien, ainsi que les efforts en matière d'éducation et d'élaboration de directives visant à assurer l'acceptation au niveau des gestionnaires de premier niveau et des collègues, doivent bénéficier de l'engagement ferme du personnel de niveau supérieur. Ce n'est que lorsque tous ces éléments se rejoindront que le milieu de travail pourra devenir le centre créatif et productif si nécessaire au bien-être de notre société.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

1120

RECRUITMENT AND RETENTION INITIATIVES FOR WOMEN IN TECHNICAL FIELDS

Marcia Braundy of the WITT National Network

The overview of strategies and activities being undertaken to increase and enhance the participation of women in technical occupations provides a broad spectrum of government, employer/union, and community based initiatives. The importance of providing the initial exploratory training for those women with little prior experience cannot be overstressed. In a culture that does not encourage women in these directions, hands-on exploration is essential to making informed career choices and building the self esteem needed to be successful in technical fields. After technical training, special measures may need to be undertaken for recruitment and hiring practices to be effective. Once on the job, training and support strategies, and the education and policy work needed to ensure acceptance at the front line manager/co-worker level must be given strong senior level commitment. It is only when all of these elements are working well together that the workplace has the potential to become the creative, productive centre so necessary to our well being as a society.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque International GASAT 7, Canada, 1993

RECRUITMENT AND RETENTION OF GIRLS AND WOMEN IN SCIENCE, ENGINEERING AND TECHNOLOGY

Linda Skidmore

(1) Décrire les composantes d'un échantillon des nombreux programmes d'intervention établis dans les secteurs privé et public avec pour objectif d'accroître la participation des citoyennes et citoyens américains dans les cours postsecondaires de mathématiques, de sciences et de génie;
(2) Analyser les caractéristiques semblables aux divers programmes, considérées comme étant efficaces pour répondre à cet objectif, particulièrement en ce qui concerne les femmes; et
(3) Parler des méthodes de mise en oeuvre de tels programmes à une plus grand échelle.

Il est important de renseigner les gens sur les programmes d'intervention qui sont efficaces, de façon à ce que l'on ne tente pas de réinventer la roue ou d'introduire un programme d'intervention qui s'est avéré inefficace par le passé pour recruter et retenir plus de femmes dans les sciences et dans le génie. Pendant la conférence de 1992 sur les programmes d'intervention en sciences et en génie, parrainée par le Committee on Women in Science and Engineering du Conseil national de recherches, on s'est aperçu qu'il existait un grand nombre de programmes d'intervention mais (1) qu'on était très peu souvent au courant de leur existence et (2) qu'on les avait rarement évalués pour déterminer si leurs objectifs avaient été atteints. On propose que les présentations des programmes individuels, en plus de décrire les composantes de ces programmes, incluent les objectifs suivants :

- recueillir le soutien institutionnel pour un programme d'intervention particulier;
- fixer des objectifs réalistes pour ce programme d'intervention;
- élaborer un programme d'intervention qui réponde aux besoins du groupe cible;
- évaluer l'efficacité du programme d'intervention; et
- s'assurer que les programmes mis en oeuvre soient terminés.

RECRUITMENT AND RETENTION OF GIRLS AND WOMEN IN SCIENCE, ENGINEERING, AND TECHNOLOGY

Linda Skidmore, Director for the Committee on Women in Science and Engeering (CWSE), National Research Council/National Academy of Sciences, Washington, USA

The intervention Projects in Postsecondary Education and Research Findings about them:

- To describe components of a sample of intervention programs from the wide spectrium known to have been established in the private and public sectors with the objective of increasing the participation of U.S. citizens, both men and women, in postsecondary math, science, and engineering education;

- To analyze the characteristics shared by programs considered effective in meeting that objective particularly in regard to women; and

- To discuss methods of implementing such programs on a broad scale.

It is important to disseminate information about effective intervention programs so that one does not reinvent the wheel or introduce an intervention that has proved to be ineffective in recruiting and retaining women in science and engineering. At the 1992 conference S&E interventions sponsored by the National Research Council's Committee on Women in Science and Engineering, it became evident that many interventions are in place but that (l) knowledge about them is not widespread and (2) few have been evaluated to deternine whether their goals are being reached. It is proposed that presentations about individual programs will not only describe the components of those programs, but also
include the following information:

. Garnering institutional support for a particular intervention,
. Determining realistic goals for that intervention,
. Developing an intervention responsive to the needs of the targeted group,
. Evaluating the effectiveness of the intervention, and Ensuring the longevity of a program until its goals are attained.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

THE EMERGENCE OF GASAT AWARENESS IN AUSTRALIA, CANADA, NEW ZEALAND AND NIGERIA: COMPARISONS AND CONTRASTS

Lesley Parker, Ann Holmes et Sharon Haggerty,
Bev Farmer, Rose Agholor

Lors des précédentes conférences GASAT, quelques participantes et participants ont présenté des rapports en vue de documenter et d'analyser certains aspects particuliers de l'Association GASAT et de ses conférences. C'est une facette importante de notre travail, que nous ne pouvons nous permettre de négliger si nous voulons éviter que certains dossiers et impressions disparaissent au point d'être irrécupérables. Ce symposium représente le début d'une analyse comparative internationale sur l'émergence de la prise de conscience du problème de GASAT dans quatre pays. Une représentante de chaque pays présentera une analyse essentiellement socio-historique couvrant les aspects pertinents du contexte culturel, du climat politique, des événements ou projets clés des principaux résultats à date et des pronostics pour l'avenir. Nous espérons qu'un grand nombre des participantes et participants de GASAT 7 partageront et ajouterons à nos réflexions, et seront éventuellement incités à contribuer à l'historique sociale de GASAT en répétant l'exercice dans leur propre pays.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

1124

THE EMERGENCE OF GASAT AWARENESS IN AUSTRALIA, CANADA, NEW ZEALAND AND NIGERIA: COMPARISONS AND CONTRASTS

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At previous GASAT conferences a small number of participants have presented papers which documented and analyzed some aspects of the GASAT Association and its conferences. This is an important aspect of our work, and one which needs to be attended to regularly, before some of the records and impressions fade to the point of being irretrievable. This symposium represents the beginnings of an international comparative analysis of the emergence of awareness of the GASAT problem in four countries. A representative of each country will present an essentially socio-historical analysis covering relevant aspects of the cultural context, political climate, key events or projects, major outcomes to date, and projections for the future. We hope many participants at GASAT 7 will come, share and add to our reminiscences, and perhaps be inspired to add to the GASAT social history by repeating the exercise in their own countries.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

RECONNECTING SCIENCE: THOUGHTS FOR A NEW MODEL

Rosalind Cairncross

La science, tel que nous la connaissons, est généralement représentée comme un corpus de connaissances distinct de toutes les autres matières, libre de tout parti pris personnel ou culturel, qui rarement, sinon jamais, reconnait les origines chez les autres cultures et qui est traditionnellement masculin. Les femmes sont rarement prises en compte et leur contribution passe fréquemment inaperçue et est dévalorisée.

Cette version de la science a donné naissance à une culture des consommateurs dans le cadre de laquelle un nombre relativement restreint de personnes utilisent la majeure partie des ressources globales, qui, en plus de frapper les diverses cultures, appauvrit les femmes. On exporte régulièrement cette culture à l'étranger au nom du commerce, de l'aide et, parfois, en guise d'expiation. Elle a également permis à ses partisans de se déculpabiliser des conséquences du développement.

Pour reconnecter la science, nous aurons besoin d'un ou, de plusieurs modèles nouveaux, qui engloberont le modèle plus étroit et plus spécialisé de la science «patriarcale» et le modèle intégré, «plus féministe». Ce dernier modèle est fondé sur la prémisse qu'il est essentiel que la science se transforme ainsi si l'on veut réaliser des progrès utiles dans les questions environnementales et sociales.

L'établissement de nouveaux modèles nécessitera de repenser sérieusement la science telle que nous la connaissons. Un modèle intégré doit non seulement être relié aux autres domaines de connaissances, il doit aussi inclure les ingrédients essentiels suivants : les connaissances des femmes, les connaissances des indigènes, une redéfinition du mot «développement» et une place centrale pour les femmes. Les femmes sont potentiellement (bien que pas inévitablement) mieux placées que les hommes pour développer ce modèle.

Les participantes et participants au symposium sont invités à faire leurs suggestions pour de nouveaux modèles et à prendre part aux discussions.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

RECONNECTING SCIENCE:THOUGHTS FOR A NEW MODEL

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Science as we know it is generally portrayed as a body of knowledge disconnected from other fields, independent of personal or cultural bias, one which rarely, if ever, acknowledges origins in other cultures and overwhelmingly male. Women are seldom seen and their contributions are either go unrecognised or are devalued.

This version of science has made possible a consumer culture in which a relatively small number of people use the major portion of the world's resources, which has overtaken cultures and empoverished women. It is routinely exported abroad in the name of commerce, aid and sometimes in acts of atonement. It has also allowed its practitioners to remove themselves from the consequences of development.

Reconnecting science will require a new model or probably models: going from the narrow and highly specialised model of "patriarchal" science towards an integrated, more "feminist" model. The latter is based on the idea that it is essential for science to transform itself in this manner if useful progress is to be made on environmental and social issues.

The development of new models will need a substantial rethinking of the science that we know. An integrated model needs not only to reconnect itself to other fields of knowledge but include women's knowledge, indigenous knowledge, a redefinition of 'development' and a central place for women as essential ingredients. Women are potentially (though not inevitably) in a better position than men to develop this model.

Symposium participants are invited to offer thoughts for new models and join in the discussion .

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

IF WOMEN RAN SCIENCE

L.E. Dyck, K. Green, T. MacNeil et J. Schmitz

Une des stratégies populaires visant à sensibiliser les gens au besoin de recruter plus de femmes dans les sciences naturelles est d'utiliser des modèles à imiter féminins accomplies. Cette pratique n'est pas sans difficulté, car elle a tendance à sous-estimer l'importance des barrières auxquelles font face la plupart des femmes qui ont essayé d'obtenir ou ont obtenu une carrière en sciences naturelles. Les femmes dans le domaine des sciences qui constituent la norme deviennent invisibles derrière des femmes si imposantes et loquaces. Les femmes qui constituent la norme et qui expriment leurs désirs peuvent être considérées moins crédibles et s'exposer à bien des déboires. Nous abordons le besoin d'en faire davantage pour encourager plus de femmes à entrer dans les sciences; pour cela, il nous faut modifier les sciences elles-mêmes. Nous parlons aussi du besoin de modifier les conditions en vertu desquelles les femmes apprennent et pratiquent les sciences et nous traitons du besoin de prévenir la perte des femmes qui sont déjà dans le système, en modifiant leurs conditions de travail. Nous parlons également du besoin de diriger la recherche future sur les femmes invisibles qui travaillent dans le domaine des sciences - celles qui n'ont «pas réussi» dans le domaine des sciences et celles qui n'ont «pas réussi» tout court. Cette stratégie fournira des données solides et qualitatives qui nous permettront de comprendre ce qui arrive à la majorité des femmes dans le domaine des sciences plutôt que de nous fier sur des preuves anecdotiques provenant de femmes assez loquaces pour exprimer leurs préoccupations.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

IF WOMEN RAN SCIENCE...

L. E. Dyck, K. Green, T. MacNeil and J. Schmitz,
University of Saskatchewan

One of the popular strategies to increase awareness of the need to recruit more women into the natural sciences is to use visibly successful female role models. This practice is not without its problems, as it tends to trivialize the significant barriers which the vast majority of women who have tried to enter or who have managed to enter careers in the natural sciences have faced and continue to face The women in science who represent the norm become invisible by comparison to such highly visible and vocal women. Women who represent the norm who do speak out may be seen as less credible and they may expose themselves to backlash. Our presentations address the need to do more than encourage more women to enter science; we need to change science itself. We address the need to change the conditions under which women learn and practice science and we address the need to prevent the loss of those women who are already in the system by changing the conditions under which they work. We will also address the need to shift the focus of future research to the invisible women working in science - those women who were unsuccessful at getting into science and those who are unsuccessful in the traditional sense. This strategy will provide sound, qualitative data to understand what is happening to the majority of women in science rather than relying on anecdotal evidence from individual women strong enough to voice their concerns.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

THE «SECOND-TIER» ANALYSIS

Sheila Tobias

Sheila Tobias maîtrise l'art et la science de la marginalité dans les programmes d'études. Ni mathématicienne, ni travailleuse scientifique, Sheila a attaqué la question de savoir pourquoi les étudiantes et étudiants de collège intelligents et motivés éprouvent des difficultés dans certaines matières telles que les mathématiques et les sciences. Son travail a donné naissance à six publications : *Overcoming Math Anxiety* (1978), *Succeed with Math* (1987), (avec le physicien Carl T. Tomizuka), *Breaking the Science Barrier* (1992), *Revitalizing Undergraduate Science: Why Some Things Work and Most Don't* (1992), *Overcoming Math Anxiety (Revised Edition)* (automne 1993) et *Gender and Politics: The Legacy of the New Feminism in America* (publication prévue pour 1994).

Diplômée d'histoire et de littérature des universités Harvard-Radcliffe et Columbia, Sheila Tobias a été conférencière en histoire et sciences politiques aux universités d'Arizona et de Californie (San Diego), administratrice de collège aux universités Cornell et Wesleyan et conseillère scolaire au collège pour femmes Stephens, à Columbia, Mo. Ses oeuvres sur le sujet de l'évitement et de l'anxiété à l'égard des sciences et des mathématiques ont été financées par le Lilly Endowment, les fondations Rockefeller et Ford et le Fund for the Improvement of Postsecondary Education du ministère de l'Éducation, ainsi que par la Research Corporation.

Dans cet atelier, Sheila Tobias nous parlera de l'analyse «de deuxième rang», de la façon de s'en servir pour faire progresser le recrutement et l'avancement des femmes dans le domaine des sciences.

THE "SECOND-TIER" ANALYSIS

Sheila Tobias
Tucson, Arizona

Sheila Tobias has made a science and an art of being a curriculum outsider. Neither a mathematician nor a scientist, she has tackled the question of why intelligent and motivated college students have task-specific disabilities in certain disciplines, particularly mathematics and science. From her work have come six books: *Overcoming Math Anxiety* (1978), *Succeed with Math* (1987), (with physicist Carl T. Tomizuka) *Breaking the Science Barrier* (1992), *Revitalizing Undergraduate Science: Why Some Things Work and Most Don't* (1992), *Overcoming Math Anxiety (Revised Edition)* (Fall 1993) and *Gender and Politics: The Legacy of The New Feminism in America* (to be published in 1994).

Educated in history and literature at Harvard-Radcliffe and Columbia Universities, Sheila Tobias has been a lecturer in history and political science at the Universities of Arizona and of California, San Diego, a college administrator at Cornell and Wesleyan Universities, and a trustee of Stephens College, a woman's college in Columbia, Mo. Her work in science and mathematics avoidance and anxiety has been funded by the Lilly Endowment, the Rockefeller and Ford Foundations, and the Fund for the Improvement of Postsecondary Education in the Department of Education, as well as by Research Corporation.

In this session Sheila Tobias will discuss the "second-tier" analysis, how can it be used to further the recruitment and advancement of women in science?

DESIGN AND TECHNOLOGY

Kathy Browning

Ma contribution à GASAT 7 examinera les diverses façons d'améliorer les contextes scolaires et professionnels des femmes dans les domaines du design et de la technologie. Des stratégies de changement, dont la conception du programme d'études; l'ordinatique; le recrutement; la rétention; et de nouveaux secteurs d'emplois techniques pour les femmes. Un document explique également comment encourager les femmes à choisir les domaines techniques et de modèles à imiter et de programmes d'études qui tiennent compte du sexe.

En nous basant sur mes expériences d'enseignante dans des cours de métier à l'élémentaire et au secondaire, de conceptrice industrielle et d'auteure principale du texte Design and Technology (Browning, Heighington, Parvu & Patillo, 1993), nous suggérons ici une synthèse d'interventions. Ces interventions, lorsque développées dans un cadre pédagogique, encouragent une certaine transformation dans le secteur de la technologie. Le rapport intitulé Girls and Women in Medicine, Math, Science, Engineering and Technology (Beauchamp & Feldberg, 1991), le texte Design and Technology (1992), mes expériences de femme dans les secteurs techniques et les expériences d'autres femmes conceptrices industrielles seront abordés.

DESIGN AND TECHNOLOGY

Kathy Browning

Ontario Institute for Studies in Education, Toronto, Canada

ABSTRACT

This GASAT 7 contribution will look at ways to improve educational and professional situations for females in Design and Technology. Strategies for change will be examined from a variety of perspectives including curriculum design; computer technology; recruitment, retention, and new areas of employment for females in technical fields. Ways of encouraging females into technical fields as well as role modelling and gender-sensitive curricula will also be discussed.

Drawing from my experiences as an elementary and secondary Industrial Arts teacher, industrial designer and senior author of the text Design and Technology (Browning, Heighington, Parvu & Patillo, 1993), a synthesis of interventions will be suggested. These interventions when developed through education would encourage a transformation in technology to occur. The report on Girls and Women in Medicine, Math, Science, Engineering and Technology (Beauchamp & Feldberg, 1991) the Design and Technology (1992) text, my experiences as a female in technical fields and those of other female industrial designers will be discussed.

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LES FEMMES EN GÉNIE...

Caroline Godin and Josée Lafrenière

The advancement of the status of women in some countries throughout the world has grown considerably in the last two decades. However, much remains to be done. Some fields, such as engineering, are not favoured by young women. Why? Are there ways to encourage them in pursuing studies in such a field? In the next few paragraphs, you may not find answers to all these problems, but you should be able to understand the point of view of female engineering students.

At a young age we often wonder what it would be like to be an adult, and our interest often lies in occupations or professional careers such as nursing or hairstyling. The problem is that we simply ignore this fact: there are female engineers and female researchers, and these women are happy in the career they chose!

Although the number of young women in sciences and engineering has been increasing over the last ten years, nonetheless, this field appears to be traditionally male. In fact, some young women do not appreciate particularly the fact that the faculty staff is almost entirely comprised of men with a poor understanding of difficulties encountered by women. Others contend that the low number of young women in engineering is simply due to the fact that this profession does not appeal to them. We will therefore attempt to separate social myths from what is simply a matter of taste for women.

One thing is certain, to successfully complete studies in a non-traditional field is a great social challenge. On this, women in engineering are unanimous. To succeed in an engineering course one needs not a superior intellect, but rather a strong will to change a discriminating world. Thus we must all ponder over several questions: How are young women treated by their male counterparts at university? Do women wishing to embark on a study program in this field get sufficient support from their immediate family and close friends? How are such programs being promoted by universities? Does physics have a gender? Does the male teaching staff take advantage of the fact we are in a minority position to make uncalled-for comments and jokes?

Indeed, we believe it would be useful to listen to what female students have to say on the matter. They can in fact respond to many such questions because they actually experience this situation daily within the confines of our universities. Perhaps once a full understanding of the prevailing situation is achieved we will be more capable of promoting a most fascinating profession!

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

LES FEMMES EN GÉNIE...

Caroline Godin et Josée Lafrenière
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L'avancement du statut de la femme dans certains pays du globe, a connu un essor considérable depuis les vingt dernières années. Il reste toutefois beaucoup de choses à faire. Certains domaines, tel le génie, n'obtiennent pas la préférence des jeunes filles. Pourquoi ? Y a-t-il un moyen pour les inciter à étudier dans de tels domaines ? Au fil des prochains paragraphes, vous ne trouverez peut-être pas de solutions à tous ces problèmes, mais il vous sera cependant possible de comprendre le point de vue des étudiantes en génie.

Introduction

Lorsque nous sommes jeunes et que nous nous arrêtons à réfléchir sur ce que nous aimerions faire lorsque nous serons grandes, nos intérêts se portent souvent vers les métiers et professions les plus connus tel infirmière ou coiffeuse.Le problème est qu'on ignaure tout simplement qu'il y a des ingénieures et des chercheuses et qu'elles sont heureuses!

Bien que le nombre d'admission des filles en sciences et génie tend à croître depuis les dix dernières années, il n'en demeure pas moins que ce domaine semble être surtout destiné aux hommes. Effectivement, certaines filles ne semblent pas apprécier que le personnel enseignant soit constitué presqu'en totalité d'hommes comprennant mal les problèmes des femmes . Par contre, d'autres soutiennent que le nombre restreint des filles en génie s'explique tout simplement parce ce que cette profession n'est pas attirant pour le genre féminin. Il nous reste donc à tenter de faire la part des choses entre les mythes sociaux et tout simplement le goût des femmes.

Chose certaine, réussir ces études dans un domaine non-traditionnel est un grand défi social. Là-dessus les filles en génie sont unanimes: il ne faut pas être doté d'une intelligence supérieure pour réussir ses études en génie mais plutôt déborder d'une vonlonté à changer ce monde au caractère discriminatoire.

Donc, nous devons nous interroger tous ensemble: comment les filles sont-elles traitées à l'université par leurs confrères? Les femmes qui désirent entreprendre des études dans ce domaine sont-elles suffisamment encouragées par leur entourage? Quelle promotion est faite à partir des universités? La physique a-t-elle un sexe? Le professeur profite-t-il du fait que nous sommes minoritaires pour faire des remarques ou des farces déplacées?

Enfin, nous croyons qu'il serait utile d'écouter ce que les étudiantes ont à dire. En fait elles possèdent la réponse à bien des questions car la réalité elles la vivent à chaque jour dans les murs de nos universités. Peut-être, qu'une fois que nous aurons compris ce qui ce passe vraiment, nous serons plus aptes à promouvoir une profession des plus passionnante!

EMPOWERING WOMEN IN SCIENCE

Jan Harding

Comment peut-on donner aux femmes, dont celles, nombreuses, qui couvent un sentiment d'aliénation aux sciences, la force nécessaire pour entrer dans le monde des sciences et de la technologie qui, à juste titre, est aussi le leur?

On pourrait tout d'abord envisager, par le biais des nombreux réseaux de femmes existants, de démontrer combien les sciences et la technologie sont importantes dans leur vie.

Les Women's Institutes d'Angleterre, qui comptent plus de 300 000 membres dans 70 fédérations de comté, sont plus communément connus pour leurs bonnes confitures, leurs choeurs chantants et leurs décorations florales. Toutefois, en 1992, soixante membres, représentantes de fédérations, se sont rencontrées pour une semaine complète d'activités liées aux sciences. Le programme qu'elles ont choisi a démontré leur engagement à organiser des expériences semblables pour les membres de tout le pays l'année suivante.

La première étape de ce projet a été documentée dans un article présenté lors du colloque GASAT est-ouest-européen de 1992. Dans cet atelier, un choix d'activités du programme sera présenté aux participantes et participants.

Que feriez-vous avec des bouteilles de vin, des éléphants roses ou du liquide de cuisine?

Venez écouter nos représentantes des WI se défendre au nom de toutes leurs membres.

Est-ce une stratégie du futur?

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

EMPOWERING WOMEN IN SCIENCE

Jan Harding
Equal Opportunity Consultant, U.K.

How may women, many of whom feel alienated from science, become empowered to enter into the heritage of science and technology which is rightly theirs?

One strategy might be to work through existing women's networks, attempting to show the relevance of science and technology to their concerns.

Women's Institutes in Britain, with more than 300,000 members organised in 70 County Federations, are more commonly known for jam, singing and flower arrangements, but in 1992 sixty members, representing their Federations, met for a week of science-related activities. Their selection for the course carried a commitment to facilitate similar experiences for members throughout the country in the following year.

The first stage of this project was reported in a paper contributed to the East-West European GASAT Conference in 1992. In this workshop a selection of activities used on the course will be available for participants to try out.

What would you do with wine bottles, pink elephants and washing-up liquid?

Come and hear what our WI representatives arranged for their members and how they responded.

Is this a strategy for the future?

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

WORKSHOP FOR MEN ON: INCLUDING MEN IN GENDER-INCLUSIVE SCIENCE

Colin Hocking

L'atelier suivra le format du document portant le même titre et des questions connexes soulevées pendant les discussions du colloque international GASAT. On demande aux participants du colloque GASAT d'examiner, d'un point de vue féministe, leur contribution à l'égard de l'élaboration et du développement des sciences et de l'enseignement des sciences sans distinction des sexes. Nous discuterons de ce que les hommes devraient faire pour éliminer l'inégalité de pouvoir qui existe entre les hommes et les femmes au sein de notre société. Nous parlerons également des approches et contributions des hommes aux initiatives visant l'égalité des sexes et de la reconnaissance que les hommes devraient accorder aux différentes expériences des femmes dans ce processus. Nous essayerons également de lancer la discussion sur les expériences des femmes de la déshabilitation et de l'aliénation des sciences institutionnelles. Nous parlerons plus en détail de la façon dont l'atelier sera organisé avec les personnes responsables d'organiser le colloque, de façon à en maximiser l'à-propos et l'utilité. Une approche éventuelle, qui rejoint quelque peu les procédés de certains ateliers de prise de conscience et d'égalité des chances à l'intention des hommes, fait participer les femmes à la négociation du choix du contenu de l'atelier, contrôler la discussion et fournir le feedback, pendant que les hommes s'occupent de l'organisation, de l'élaboration et de l'animation de l'atelier.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

WORKSHOP FOR MEN ON:
INCLUDING MEN IN GENDER - INCLUSIVE SCIENCE

Colin Hocking, Victoria University of Technology,
Melborune, Australia

The workshop will follow on from the paper of the same title, and associated points arising out of discussion at the GASAT conference. The workshop asks male participants at the GASAT conference to consider, from a pro-feminist perspective, their contribution to formulating and developing gender-inclusive science and science education. We will discuss how men should act within the unequal power relations between males and females in society. We will also talk about what approaches and contributions men can make to gender-inclusive developments, and what recognition men should give to the different experiences of women in this process. We will also endeavour to set the discussion within the framework of women's experiences of disempowerment and alienation from institutional science. Details of how the workshop will be arranged will be discussed with the organizers of the conference, to maximize its appropriateness and usefulness. One possible approach, that parallels the processes of some patriarchy awareness and equal opportunity workshops for men, involves women in negotiating the content of the workshop, monitoring the discussion and providing feedback, while men take responsibility for organizing, developing and facilitating the workshop.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque International GASAT 7, Canada, 1993

TECHNOLOGY IN THE CLASSROOM

Nancy Moore

Dans un monde en évolution rapide, les établissements primaires ne cessent d'être mis au défi de définir et de fournir un programme d'études pertinent. Les enfants en âge d'aller à l'école primaire ont naturellement tendance à être curieux; leur motivation inventive n'est pas encore freinée par des idées préconçues de ce qui est ou n'est pas acceptable. Ils veulent parler de leurs expériences. Design and Technology tente de se pencher sur ce qui existe déjà et de relier le tout sous une perspective très différente. Celle de concevoir, communiquer, fabriquer, tester, évaluer et encourager les enfants à aller au-delà de leurs premières idées et de chercher des solutions de rechange, de façon à ce qu'ils conçoivent des modèles plus efficaces qui peuvent influencer et contrôler le milieu dans lequel ils vivent.

Cet atelier, Technology in the Classroom, donne la possibilité aux participantes et participants de montrer à quel point la technologie fait partie du milieu naturel de l'enfant. Nous recherchons des façons d'identifier et d'intégrer la technologie dans le milieu d'apprentissage actif de la salle de classe par le biais d'expériences pratiques.

Les participantes et participants seront priés d'utiliser le matériel à leur disposition pour concevoir et fabriquer un nouvel objet, d'utiliser des objets domestiques pour en apprendre plus sur de simples machines et sur la raison pour laquelle les livres pour enfants peuvent représenter un point de départ pour les expériences en technologie et en sciences. Dans le cadre de cet atelier, on aura également recours à des diapositives du travail des enfants.

Tout au long de l'atelier, on fera un modèle de l'approche qui met l'accent sur l'équité des sexes dans la salle de classe.

TECHNOLOGY IN THE CLASSROOM

Nancy Moore, Toronto

In a world of rapid change, primary and junior education continues to be challenged to identify and provide relevant curriculum. Elementary school children naturally tend to an investigative style of learning; their inventive urge is not inhibited by preconceived notions of what is acceptable. They have the desire to communicate about what they have been involved in. Design and Technology involves looking at what is already happening and putting it together rather differently. It is about designing, communicating, making, testing, evaluating and encouraging children to go beyond their first ideas and seek alternatives so that they make more effective models that can influence and control the environment in which they live.

In this workshop, Technology in the Classroom, one will provide opportunities to show how technology is a natural part of the child's environment. We will investigate ways to identify and integrate technology into the active learning environment of the classroom through hands-on experiences.

The activities that the participants will engage in will be using found material to design and make a new object, using household objects as ways to learn more about simple machines, how children's literature can be a starting point for technology and science experiences, as well, kit technology will be discussed through slides of children's work.

Throughout the workshop, one will model the approach that enhances gender equity in the classroom.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

INTEGRATING ETHICS INTO SCIENCE CLASSES AT THE UNIVERSITY LEVEL

Karen Sturgeon et Peggy Tripp-Knowles

Cet atelier est conçu pour examiner les avantages, les problèmes et les conséquences associés à l'incorporation de l'éthique dans les cours de sciences du niveau universitaire. Les questions d'éthique donnant lieu à préoccupation incluent, sans pourtant s'y limiter, la responsabilité environnementale et sociale dans les sciences. L'atelier inclura une étude de cas en petits groupes, suivie d'une discussion entre les participantes et participants et les animatrices et animateurs sur les expériences et les préoccupations.

Contributions - GASAT 7 International Conference, Canada, 1993
Les soumissions - Colloque international GASAT 7, Canada, 1993

1142

INTEGRATING ETHNICS INTO SCIENCE CLASSES AT THE UNIVERSITY LEVEL

Kareen Sturgeon, Linfield College, Oregan and
Peggy Tripp-Knowles Lakehead University, Canada

This workshop is designed to explore benefits, problems and consequences associated with incorporating ethics into science courses at the university level. Ethical issues of concern will include but not be limited to environmental and social responsibility in science. The format will include a case study analysis in small groups followed by a discussion among participants and presenters of experiences and concerns.

Contributions - GASAT 7 International Conference, Canada, 1993
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1144